MAY 14 1926

VOL. X MARCH, 1926 No. 1

The Journal of APPLIED PSYCHOLOGY

EDITORS

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PUBLISHED BY THE EDITORS
THE WILLIAMS & WILKINS CO.
Mount Royal and Guilford Avenues
Baltimore, Md.

Entered as second class matter June 3, 1924, at the post office at Baltimore, Maryland, under the act of March 3, 1879.
Acceptance for mailing at special rate of postage provided for in section 1103, act of October 3, 1917, Authorized December 21, 1922.

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The Journal of Applied Psychology is published quarterly. The subscription price is $5.00 a year. Single numbers $1.50. Remittances and business communications should be addressed to the Editors, James P. Porter, Ohio University, Athens, Ohio, or to William F. Book, Indiana University, Bloomington, Indiana.

LEARNING AND STABILITY[1]

A Psychophysiological Analysis of a Case of Motor Learning with Clinical Applications

GEORGE S. SNODDY

Indiana University

I

The belief that motor coördinations may have a discoverable psychophysiology and the hope that a detailed analysis of one of the simplest coördinations it is possible to keep under conditions of adequate scientific control may throw some light on the problem and be of service in the clinical field have led to this investigation. It is evident to all workers in the quantitative aspects of motor learning that few serious attempts have been made to study the physiological side of the establishment of motor coördinations. As evidence of this fact one may note that one of the most popular theories of the process of motor learning assumes that the coördination rests essentially upon the survival of good accidents. The fact that the loss of coördinations in an abnormal subject is today generally accepted as another accident is to be expected. The application to the clinical field may be, in the end, the best test of the validity of our analyses of the mechanics of learning.

An earlier study of the author's (Psycho. Rev. Mono. Sup. No. 124) dealt mainly with the introspective and qualitative aspects of a case of trial and error learning in the human subject.

[1] This study was carried out in the laboratory and psychological clinic of the University of Utah. The writer is very greatly indebted to President George Thomas, of the University of Utah, who has encouraged this research through special grant of time and funds, and to his advanced students who have aided the writer in collecting the data through individual examinations over a period of six years.

The present study will deal with the quantitative and clinical aspects of this same problem.

II. THE STABILIMETER

Our analysis has involved the development of a highly specialized form of mirror tracing. To get essential experimental controls we have had to perfect a mirror tracing device which we call the *stabilimeter*. In our experience no form of

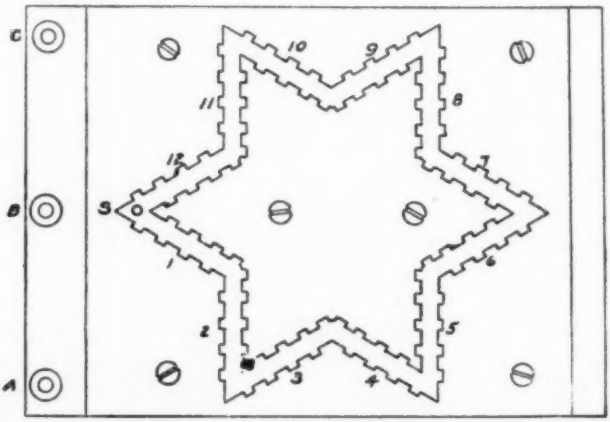

FIG. 1. DRAWING OF THE TRACING INSTRUMENT, WHICH CONSISTS OF A STAR-SHAPED PATH CUT FROM A SHEET OF BRASS

The brass plates are screwed to a heavy glass plate. The starting point is S and the sides of the paths are traversed in the order indicated. *A*, *B*, and *C* are binding posts. This instrument is obscured from direct vision by a screen.

mirror tracing, as usually studied in laboratory classes, is at all capable of furnishing the experimental controls necessary for a serviceable analysis of this coördination. The *stabilimeter* consists of a tracing instrument involving a path to be traced, a mirror producing a good image, a soft copper stylus to be used pencil-fashion for tracing the path, and an apparatus for counting the electric impulses. The tracing instrument involves a sheet of brass, from which has been cut a star-shaped

path one-fourth inch in width. The brass sheet is mounted upon a heavy glass plate. Niches are cut in the sides of the path to prevent sliding of the stylus along the edge of the path[2] (see fig. 1). The glass plate forming the bottom of the path is kept clean and without scratches. Electrical connections are made between the brass plate, the stylus and the electric counter. For the latter we have used the Stoelting electric counter, and at times the Western Electric *P.B.X.* message register. Contacts made between the stylus and the brass plate are recorded by the counting mechanism. Time is kept with a stop watch. The one-hundred second type has been found the most serviceable.

As indicated above, our subjects follow the path of the star-shaped design by means of the mirror image, the direct vision of hand and tracing instrument being obstructed by a screen so placed as to give unobstructed mirror vision of the hand and tracing instrument but to obstruct the direct vision.

III. CONTROL THROUGH INSTRUCTIONS

Our first experimental difficulty is concerned with the control of the subject's attitude. One subject who is told to "trace around the path as rapidly as possible and make as few errors as possible" will concentrate his attention upon the avoidance of errors; while another subject, with the same instructions, may devote more of his attention to the securing of speed. The results in the two cases are often not comparable. Early in our work we found that attempts to juggle the two scores, time in seconds and contacts or errors, by methods involving mathematical devices, were doomed to failure unless these methods involved the true mathematical relation of the time

[2] The effect of these niches is merely to force the subject out in the path and to quickly acquire the coördination. All of the findings in this study have been verified by checking against data secured from instruments with smooth edges. The data in the two cases are entirely comparable provided the experimenter sees to it that the beginner does not slide his stylus along the edge of the path when the straight edges are used. The niches force the subject to adopt the learning attitude at once.

and error quantities themselves. This relationship was found as follows.

We had observed that with the experienced subjects an increase in speed produced an increase in the number of errors or contacts. Also, we found that if a number of highly experienced subjects be selected and kept under the instructions to "move around as fast as possible and avoid making contacts as far as possible," the average error scores and the average time scores will approach equality; that is, the time in seconds will equal the number of contacts. This gave us our pacing principle: *the time in seconds and the number of errors are kept approximately equal.* This device works splendidly. The instructions are given as above and then the experimenter controls the subject so that the time in seconds and the error count are kept equal. A subject moving too rapidly for his highest efficiency will be recording too many errors in comparison with the time he is taking, and is told to move more slowly and more carefully. If the subject has a time score greater than the error score he is told to move more rapidly. The pacing is done during the act of tracing and involves no interference or annoyance to the subject.

IV. THE MEANING OF OUR SCORES

In addition to the securing of a constant attitude from the subject at all times and one that will be the same from one subject to another, there is the question as to the meaning of the time and error scores. This problem lies so near to that of pacing that it will be discussed at this time. To avoid complications arising from the learning process, we shall at present consider only highly experienced subjects who, for practical purposes, may be regarded as having reached the limit of their improvement. When such subjects are carried through a practice involving a pacing for equality of time and error scores, and are then *gradually* changed over to emphasis upon avoidance of errors, it is found that the errors can be completely eliminated and the sum of the time and error quantities will remain a constant throughout the practice; in other words, the score (sum

of time and errors) may be reduced entirely to *time* (see table 1). The reverse process, of reducing the time taken while the errors are allowed to increase, produces no constant at all but a gradually increasing total (time plus errors) score. By methods to be presented later, which have the effect of inhibiting the learning, it can be shown that this constant relation holds—there being, of course, a change of constants as learning proceeds—for

TABLE 1

*Relation between time and error quantities among subjects who have practically reached the limit of improvement and for whom the learning factor is negligible**

SUBJECT	GOING SLOWER					GOING FASTER		
	T = E	T = 2E	T = 3E	T = 4E	E = 0	T = ½E	T = ⅓E	T = ¼E
1	21.7	23.0	21.7	21.7	21.6	23.4	28.7	30.1
2	20.6	20.4	19.9	20.0	20.4	25.3	31.7	39.7
3	20.5	19.1	21.2	20.5	21.0	26.6	33.0	39.3
4	20.3	20.7	20.4	20.2	20.0	22.7	40.0	60.0
5	25.4	25.2	24.9	25.6	25.2	30.1	35.0	49.7
6	22.8	23.3	22.0	22.4	22.0	25.0	28.6	32.8
Average.....	21.9	21.9	21.7	21.7	21.7	25.5	32.8	41.9

* In this table each score is the sum of the time in seconds and the number of errors. In the second column is shown the sum of the time and error quantities when subjects are paced for equality of time and errors. In the third column the scores represent the sum of the two quantities when the subject is asked to go more slowly, so that the error count is one-half the time score. In all cases the experimenter only, not the subject, is aware of the time and error relations. Instructions are given only during the act of tracing and consist solely of "go more slowly" or "go faster." Scores are averages of five circuits in series.

all levels of the learning curve where subjects can be paced, which includes all but the first three or four circuits in the practice of subjects of low efficiency. It holds for subjects of high or average efficiency at all points of the learning curve. However, this constant relation does not hold when the subject is not paced. As an illustration, if the subject adapted to equality of time and error scores be asked to move very slowly and avoid

errors, he will take more time than is needed as shown by the sum of the time and error scores. The subject must be worked over very gradually since any sudden emphasis upon avoiding errors is certain to involve a time factor too large for the constant sum.

Now what is the meaning of this peculiar constancy? The answer seems to rest upon the fact that we are measuring the *capacity* of a sensori-motor pattern to *endure stimulation*. The subject is moving his stylus down the middle of a narrow path. If he moves slowly he makes few errors, if he moves rapidly he makes many. In the practice involving equality of time and error scores he was asked to move at such a speed that he made one error for each second of time taken. By reference to table 1 it can be seen that this will involve the highest speed for which the constant relation holds. The time taken to make the circuit under such conditions becomes a reciprocal measure of the endurance capacity of the pattern.

Let us consider a subject who, say, makes the circuit in twenty seconds with twenty errors. This subject, at the same level of learning, will make the circuit with no errors in forty seconds; which means that if forty seconds are taken the coördination pattern is not broken; an error is a break in the coördination. It is clear that the path of the instrument is made up of stimulation points which stimulate this eye-hand coördination. In our example, the reciprocal of forty will then become a measure of the endurance capacity of the pattern to meet these stimulations. Or, to put it another way, if there were one thousand stimulation points in the path, then $\frac{1000}{40}$ or *25* would represent the number of stimulations per second the pattern could just endure without breaking.

From the above it can be seen that any *paced* score can be reduced to an endurance capacity score. In practice, we use only results secured from experiments where equality of time and errors is maintained. This is due entirely to the extreme ease of pacing the subject under such conditions. It will be seen that our proof in table 1 involves only the relation between

the time and error quantities when the learning factor is eliminated, but the relation holds, with change of constants, for all levels of the learning curve where subjects can be paced. Under such conditions, the score found from the sum of the time and

TABLE 2

*Improvement as a function of the length of time interval between circuits**

CIRCUIT	110 SUBJECTS (SERIES PRACTICE)			100 SUBJECTS (ONE-MINUTE RECESS)			80 SUBJECTS (ONE-DAY RECESS)		
	Q_1	Q_2	Q_3	Q_1	Q_2	Q_3	Q_1	Q_2	Q_3
1	3.1	5.0	7.5	3.1	5.0	7.4	2.7	5.0	7.7
2	4.6	6.1	10.0	5.4	8.7	11.9	8.3	11.4	14.3
3	5.6	7.7	10.7	7.7	10.4	13.9	11.4	14.4	17.5
4	6.7	8.5	11.9	10.3	12.7	16.8	13.3	15.9	19.3
5	7.3	10.0	12.6	10.6	14.3	17.0	16.0	18.0	20.7
6	8.5	10.5	13.5	12.3	16.1	19.4	18.0	20.0	24.0
7	9.2	11.2	14.0	13.6	17.1	20.4	18.0	20.6	24.0
8	10.0	12.3	15.3	14.5	17.2	20.3	18.6	21.8	25.3
9	9.9	11.9	15.4	15.1	18.2	22.2	20.0	22.1	25.7
10	10.7	13.1	16.0	15.5	18.9	22.8	19.7	22.0	27.1
11	10.4	13.7	17.2	16.7	20.0	23.8	20.4	23.1	26.2
12	11.6	13.7	17.0	17.7	20.8	24.3	20.8	23.9	27.4
13	12.8	14.9	18.9	18.2	20.8	26.0	20.6	24.5	27.4
14	13.0	15.4	17.2	18.5	22.0	25.8	21.3	24.8	27.7
15	13.3	15.2	18.2	18.7	22.4	26.3	21.9	25.4	27.9
16	13.3	15.4	17.9	18.5	21.4	25.7	22.8	25.7	30.2
17	13.2	16.1	18.9	19.5	23.0	26.4	22.3	25.5	29.0
18	14.3	15.9	18.9	20.3	23.8	27.7	23.1	27.6	32.5
19	13.7	16.7	19.2	20.2	24.2	28.2	23.2	27.0	30.6
20	14.5	16.7	20.0	19.7	22.9	26.3	23.0	26.7	30.4

* The scores in this table are C scores, i.e., $\frac{1000}{T+E}$, and are taken from paced practice. All conditions are identical in the three practices except the length of time interval. All subjects are inexperienced. The median scores are plotted in figure 2.

error quantities becomes a reciprocal measure of the capacity of a growing pattern to endure stimulation, and the learning curve merely marks successive stages of growth in this capacity.

These endurance capacity scores we have called C scores, since they measure *capacity* to *conduct*. The formula is C

score $= \frac{1000}{T + E}$, where T and E refer to time and errors. (In practice the reciprocal is thus multiplied by one thousand to avoid awkward decimals). The scores found by simply adding the time and error quantities we have called R scores, *raw* or *resistance* scores, since they measure, not conduction, but resistance to conduction. Thus R score $= T + E$, and C score $= \frac{1000}{R}$. The learning curve made up of R scores would be a decreasing function and would mark successive stages in the decrease of resistance to conduction.

V. THE LEARNING CURVE UNDER DIFFERENT CONDITIONS OF PRACTICE

Contrary to the widely accepted view that learning is simply a matter of so much practice, or is largely a function of repetitions alone—most laboratories conduct learning experiments as though this were true—our findings, from the outset, point to the fact that the conditions of practice are most important (see fig. 2). Thus, under pacing conditions which secure a constant attitude of the subject, the learning curve will depend upon whether repetitions or circuits of the instrument follow each other in continuous series, that is, without a time interval between successive circuits (our term here is *series practice*), or are separated by time intervals.

In case time intervals separate the circuits, the improvement in the earlier part of the practice will be a positive function of the length of the time interval. The rate of improvement is a function of the length of the time interval only during the early part of the practice, when the coördination pattern is being built. Beyond this early adaptation stage the improvement is a function of the number of repetitions. For convenience of description we have called the early stage of the curve, where the improvement depends upon. more than repetition alone, the *adaptation* stage, and the remainder of the curve where improvement is a function of repetition alone, the *facilitation* stage.

The highest initial rate of improvement we have studied

comes from practice involving one circuit per day or a constant time interval of twenty-four hours. As shown in figure 3, the facilitation portion of this curve forms a straight line on double logarithmic paper. The adaptation portion of this curve strikes the facilitation line at the sixth circuit. As will be

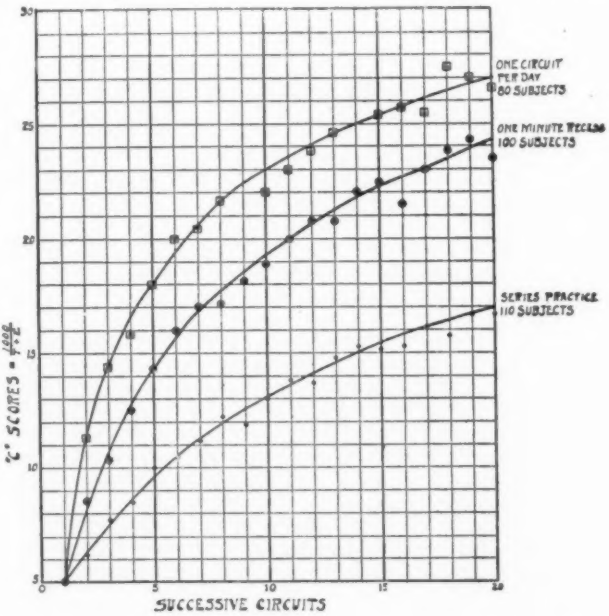

FIG. 2. IMPROVEMENT AS A FUNCTION OF THE LENGTH OF RECESS

These curves are made from the median scores taken from table 2. The subjects are all inexperienced. A slight selectionwas made tosecure subjects of equal initial ability in the different groups so that all ques tion of differences of native ability as an explanation for differences in the learning curves would be entirely eliminated.

shown later, many forms of practice eventually reach this particular facilitation level but only after much longer adaptation practice than is required under the once-per-day conditions.

1. Time interval practice. The data presented in figure 2 and table 2 show clearly that the learning is higher for time

interval than for series practice; and, in the early part of the learning curve, is higher for the longer than for the shorter time intervals. In addition to the data shown in the figures we have secured (1) data for two-minute intervals, and here the curve is above that for one-minute intervals; (2) data for intervals of one hour, and here the curve lies between that for two minutes and that for twenty-four hours.

2. Mixed or broken practice. If we consider a practice such as that shown in curve A of figure 4, where the practice consists of groups of twenty circuits, the circuits being separated by intervals of one minute and the groups by intervals of twenty-four hours, it will be seen that a negative factor enters in to depress the efficiency of initial circuits after the first day; also the facilitation line for this type of practice never reaches that for once-per-day practice. This depression also occurs if the circuits within the group are separated by longer time intervals; but the depression is not so great and the recovery is much more rapid in the case of the longer intra-group intervals. If instead of the one-minute intervals within the group we had used two-minute intervals, the smoothed facilitation line of the latter would rise to the level of the one-circuit-per-day practice by the second day. Had we used a group of forty circuits instead of twenty in our curve A practice the facilitation line for this practice would rise to the level of that for the one-circuit-per-day practice by the third day. If the time interval be kept constant the curve for the two-minute interval practice rises to

FIG. 3. DRAWING SHOWING A PLOT OF THE MEDIAN *C* SCORES OF 80 SUBJECTS FOR 60 CIRCUITS OF PRACTICE UNDER CONDITIONS OF 1 CIRCUIT PER DAY

The plot is made upon double logarithmic paper. The smoothed line in curve II is a continuation of the line shown in I. The first five stations (station one cannot be shown in the graph but may be found in table 2) constitute the *adaptation* portion of the curve and do not enter into the *facilitation* line, extending from the sixth to sixtieth circuits. The initial station in curve I, is the *B* score for the facilitation line. The *x* ordinates for curve I should be read from *1* to *10* and for curve II from *10* to *100*. The smoothing of the facilitation line was determined algebraically from the equation $\log C = \log B + n \log x$. (See text.)

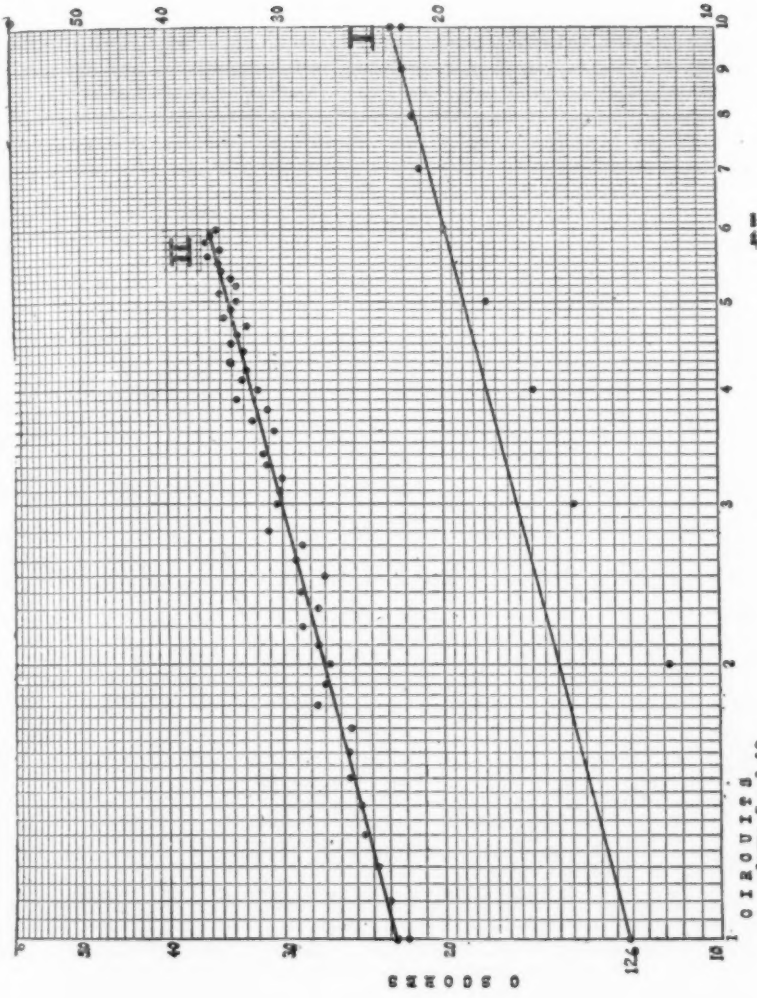
I
II
50
40
30
20
10
9
8
7
6
5
4
3
2
1
CIRCUITS
Curve I- 1-10
Curve II- 10-60
SECONDS

Fig. 3

the facilitation line of the once-per-day practice by the twentieth circuit, and the curve for the one-minute interval practice rises to the once-per-day facilitation level by the thirtieth circuit.

Series practice—practice without time intervals—presents a number of interesting phenomena. As shown by curve B in figure 4, improvement in this type of practice is terminated by fatigue by the fiftieth circuit. If instead of a long series of circuits we select a short group of, say, twenty circuits in series, and have these groups separated by a twenty-four hour time interval, a curious phenomenon is observed: no depression follows the long time interval (table 3, columns 13 and 16); instead, the time interval brings about a marked improvement. In such a practice the facilitation line of once-per-day is reached by the one-hundredth circuit. This location of the facilitation level in series practice is, of course, dependent upon the number of time intervals inserted, since the facilitation line can never be reached by one continuous series.

3. Cancellation of growth differences. From the above discussion, it can be seen that growth differences, due to varying length of the time interval, can be eliminated by the time the facilitation stage of the learning is reached in all cases of constant time interval practice; and in all groupings of circuits, where the interval within the group is long enough to overcome the depressant effect of the change from the short to the long time interval. For example, the practice consisting of twenty

---

FIG. 4. A. Plot showing data from a practice with 100 subjects doing 20 circuits per day, with one-minute intervals between circuits. First 10 circuits may be read from table 2. The dot stations are the median *C* scores of the group for each circuit. The encircled stations are the quartile points found from the distributions of 100 scores where each is the median of a subject's daily practice of 20 circuits. The *B* scores for the quartile lines are $Q_1 = 10.3$, $Q_2 = 11.5$, $Q_3 = 12.6$.

B. Curves drawn for the data secured from 110 subjects doing 60 circuits in series. The stations are plotted from the average of ten consecutive stations. (The curves are so close to linear that this holds for intervals of ten circuits.) Extreme fatigue following fiftieth circuit led to termination of practice at sixtieth circuit. Due to constriction of quartile lines this is not considered a *facilitation* level.

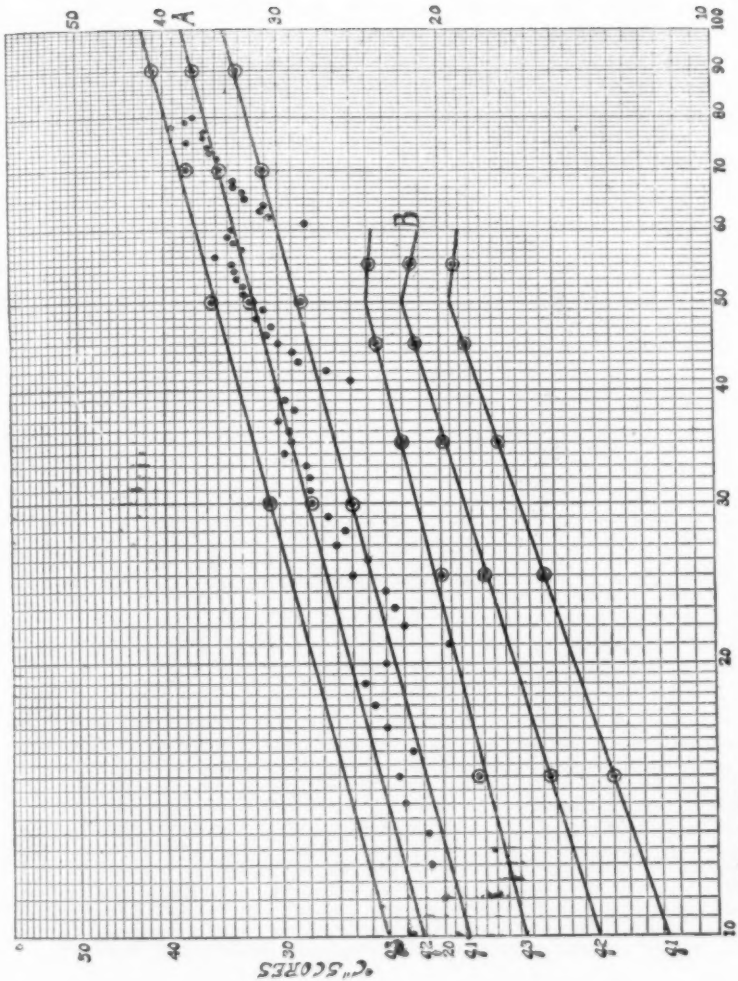

FIG. 4

circuits per day with intra-group time intervals of one minute never reaches the facilitation line of once-per-day practice;

TABLE 3

*Showing the effect of time interval and series adaptation upon subsequent circuits in series**

NUMBER OF CIRCUIT	RECESS PRECEDING CIRCUIT	Q_1	Q_2	Q_3	NUMBER OF CIRCUIT	RECESS PRECEDING CIRCUIT	Q_1	Q_2	Q_3	NUMBER OF CIRCUIT	RECESS PRECEDING CIRCUIT	Q_2	NUMBER OF CIRCUIT	RECESS PRECEDING CIRCUIT	Q_2
1		3.1	4.9	7.0	21	0	20.4	23.3	26.5	1		5.5	21	24 hr.	18.4
2	2 m.	3.6	6.8	11.0	22	2 m.	24.7	26.7	31.3	2	0	8.7	22	0	20.0
3	2 m.	8.3	11.3	15.5	23	0	20.6	25.5	28.0	3	0	9.6	23	0	20.0
4	2 m.	8.7	13.4	17.5	24	2 m.	24.0	27.7	31.5	4	0	10.2	24	0	20.0
5	0	9.3	13.0	16.8	25	0	23.0	25.8	30.3	5	0	9.5	25	0	21.7
6	2 m.	13.5	16.0	20.2	26	2 m.	25.7	30.2	33.5	6	0	11.7	26	0	21.3
7	0	12.0	15.5	18.7	27	0	23.2	28.0	32.7	7	0	11.0	27	0	19.7
8	2 m.	14.5	18.8	22.0	28	2 m.	23.7	27.2	33.2	8	0	11.3	28	0	21.8
9	0	14.3	18.3	22.0	29	0	22.7	26.5	34.0	9	0	13.2	29	0	20.3
10	2 m.	16.5	20.8	23.5	30	2 m.	25.7	30.5	35.3	10	0	12.7	30	0	23.6
11	0	15.7	18.8	22.7	31	0	23.5	27.7	34.3	11	0	13.1	31	0	22.1
12	2 m.	18.3	20.9	25.5	32	2 m.	27.4	32.0	35.5	12	0	14.2	32	0	22.0
13	0	16.6	20.6	23.4	33	0	24.0	28.5	33.7	13	0	13.9	33	0	22.4
14	2 m.	17.7	23.0	26.0	34	2 m.	26.5	31.5	36.0	14	0	14.3	34	0	22.6
15	0	17.3	22.3	26.0	35	0	23.8	29.4	33.7	15	0	15.0	35	0	22.5
16	24 hr.	16.3	19.5	24.0	36	2 m.	26.0	32.2	35.8	16	0	14.4	36	0	22.9
17	0	17.5	20.0	24.5	37	0	23.0	29.5	35.2	17	0	17.0	37	0	22.3
18	2 m.	19.5	23.6	28.5	38	2 m.	27.2	31.2	38.4	18	0	15.5	38	0	23.8
19	0	18.5	21.5	25.7	39	0	25.3	29.3	35.3	19	0	17.0	39	0	22 3
20	2 m.	21.7	26.0	31.5	40	24 hr.	26.0	29.3	34.7	20	0	17.1	40	0	24.1

* The data in this table show the effect of adapting the subjects to time interval conditions (the left two-thirds of the graph) and then shifting to circuits in series to study the effect of time interval adaptation upon the series circuits. Between the first and second, second and third, third and fourth circuits, time intervals of two minutes are interpolated. Following this, every odd numbered circuit is in series throughout the forty circuits of practice. It will be noted that every series circuits, except the seventeenth, shows a marked fall in efficiency over the preceding time interval circuit. Fifty-eight subjects were used in this test. The right third of the table shows the effect of first adapting to series practice and then inserting a time interval between the twentieth and twenty-first circuits. There is no inhibition of improvement in series circuits following the time interval and improvement takes place across the time interval. Twenty subjects were used in this test. All subjects were inexperienced. Quartile points are shown in the first test to show that the entire group are similarly affected. All scores are C scores or $\frac{1000}{T+E}$.

while, with intra-group intervals of two minutes, the line is reached by the thirtieth circuit. These details will be discussed

more completely in our analysis of adaptation phenomena and in the quantitative studies of the learning curve.

4. Fatigue and differences in adaptation. In the past it has been customary to explain by recourse to the protean conceptions of fatigue and forgetting all that we have interpreted tentatively as due to growth and adaptation processes. A careful analysis of our data, however, seems to show that fatigue, as we know it through experimental research, cannot explain these growth differences; and the conception that the time interval is responsible for certain growth and adaptational changes seems to be forced upon us. The forgetting factor seems also to be explicable in terms of adaptation.

If we compare scores from a time-interval practice with those from a series practice, we see that the differences cannot be due to fatigue. In table 2, the series curve and the one-minute curve start at the same point, then separate, and by the fourth circuit the station on the series curve is 68 per cent that of the one-minute station; and this constant percentage is maintained, with slight wave motion, to the fiftieth circuit of practice. Fatigue would not produce such initial differences and then stop abruptly. Also, if fatigue were operating in series practice it would appear that shorter groups of circuits should show steeper slopes than longer groups, which is not at all the case. In the adaptation part of the curve (see table 2) there is a constriction of scores observable when quartile points are plotted; and this constriction is very much greater for series practice than for recess practice, and decreases with the increase in the length of the time interval. In series practice, the pre-facilitation levels, therefore, show much greater slopes for the low individuals than for the high ones; in other words, the individuals requiring longer time to make the circuits are the ones making the greater improvement, which is decidedly against the conception that fatigue is operating here to produce differences in rate of improvement.

5. Growth and adaptation factors. But what can develop in the adaptation stage of the learning curve which would depend so largely upon length and number of time intervals? In

the writer's opinion it is a pattern of coördination which, through certain growth processes, rises in its capacity to endure stimulation: it is growing in adaptation. As the writer pointed out in an earlier article (Psych. Rev. Mono. Sup. No. 124), the neuromuscular pattern seems to involve a synthesis of elements which, after the time interval, approach simultaneity in their function; while, before the interval, they functioned in succession. The conceptions of nerve center changes through synaptical growth as presented in the work of Kappers and Dercum would seem to be adequate to account for the growth of these patterns. However, the conceptions of change in synaptical resistance, in our own analysis, seem to be utterly incompetent to account for the findings.

When one considers the growth taking place in once-per-day practice and compares this with that in series practice, where the only difference is one of time interval, the view seems unescapable that we are dealing with a contribution the neuromuscular apparatus itself is making to the learning process. The efficiency of this apparatus would seem to depend upon certain growth processes, and also upon its own inner state, which in turn would be expected to vary with health, heredity and emotional state. The writer is convinced that these growth processes cannot be explained in terms of such devices as frequency, recency or satisfyingness. Surely satisfyingness would work as readily in series practice to "fix" or "stamp in" random movements as it would in a practice with time intervals. One might even be permitted the opinion that this principle of selection of random movements ought to work better in series practice. We have already shown that in the facilitation portions of the curve the improvement, under certain conditions, is a function of the number of repetitions; but it will be recalled that by such time all growth differences due to variation in length of time interval have disappeared.

Certain aspects of our adaptation phenomena, however, do not appear to be reducible to growth of pattern; at least we have not been able to so interpret them. If a subject be adapted to time interval conditions in any part of the learning,

a shift to series practice conditions involves two distinct effects: first, there is a noticeable fall in efficiency beginning with the first series circuit (table 3), and second, an inhibition of improvement in the series circuits, which will endure for a variable number of series circuits dependent upon the extent of the time interval adaptation.[3] It should be recalled that if a subject be first adapted to groups of series circuits he will improve throughout each series and also in the time interval separating the groups (see columns 13 and 16, table 3). Here we see the effect of early adaptation to the time interval or series practice conditions and we have no explanation for this in terms of growth.[4]

It is difficult to indicate the temporal length of this inhibition since it depends upon the degree of time interval adaptation. A subject who began his mirror tracing in the laboratory, and has had ten circuits separated by two-minute intervals, will be adapted to the point where series of ten circuits may be run off with no improvement whatsoever within the series. Such

[3] In our references to inhibition of improvement for series practice following time interval adaptation it is not intended to convey the idea that these circuits in series count for nothing. In fact, such a view is far from the truth. If a careful study of the data in columns 1 to 10 of table 3 be made, it will be found that the improvement for the second day—beginning with the sixteenth circuit— is too great to be accounted for solely by the circuits preceded by recess. It appears that after the recess of one day the early series circuits begin to show their effect, which is very nearly what would have resulted had all the circuits been preceded by time intervals. However, during the first fifteen circuits the learning curve is precisely what should have come from the time interval circuits alone, i.e., before the long recess the series circuits have no effect upon the learning curve. While the interpretations differ widely, yet the observation that a marked improvement under conditions similar to the above follows a long time interval was made by Book in his classical study of typewriting. (See W. F. Book, The Psychology of Typewriting. Gregg Publishing Company.)

[4] In an earlier analysis of this phenomenon our conclusion was that improvement could not take place at all in series practice, but this interpretation was in error. In order to secure introspections in the earlier stages of practice, we had provided time intervals between circuits and had thus unwittingly secured inhibition of improvement in series practice through adaptation to time interval conditions.

an adaptation reappears after a long recess of a month or a year upon the introduction of one or two of the short intervals. This device for the production of inhibition of improvement in series practice is the one, mentioned in earlier pages, we have used to study the relation between the time and error quantities at various levels of the learning curve.

As we have pointed out, a phenomenon arises as the result of adaptation which is identical with forgetting, or at least very similiar to forgetting. When a subject is making a group of circuits each day, the circuits being separated by short time intervals, and the groups separated by one day, a depression follows the long recess (see curve A, fig. 4). This is quickly recovered from and, if the intra-group interval is as long as two minutes in a group of twenty circuits, or the group is as long as forty circuits with an intra-group interval of one minute, the normal facilitation line is eventually reached. We have in this phenomenon a case of adaptation to short time interval, followed by a depression upon change to a long time interval. The longer the intra-group interval the less the depression following the long inter-group interval. In practice involving one circuit per day, an interval of a week leads to no depression at all. The depression seems clearly to be a matter of the disproportion between the length of the intra-group interval and the interval between the groups. This, to the writer, seems to be an adequate explanation of forgetting in motor learning. There are marked individual differences here and certain psychopathic subjects lose enormously from this depression factor, but it is not true that low subjects, on the whole lose more than high ones.

6. Relation to biological adaptation. The writer does not find it a simple matter to generalize these adaptational phenomena. It can be seen that inhibition occurs for those conditions which produce the lowest rate of learning, and in general it can be seen that intermittent stimuli which are free from inhibition are the rule in nature rather than the exception. A factor which seems to point to biological adaptation is seen in our conception of synthesis following the time interval. A

movement following a time interval is made up of a synthesis or simultaneous functioning of muscular elements which functioned alternately before the recess as right and left zig-zag movements across the path. The coördination resulting from this synthesis is not in a sense a new movement at all; if, however, series practice is begun, entirely new movements do arise. It is no doubt this appearance of new movements which lowers the efficiency and produces an inhibition—as indicated in the preceding section—at the time when improvement is coming from a growing synthesis. If an animal is escaping from an antagonist the coördinations already built up may avail but, if they do not, series stimulation will result which leads to a great change in the character of the movements, not to the building up of a new coördination.[5] Overstimulation of a pattern leads to breakdown of the coördination: its endurance capacity is exceeded; and this leads to the appearance of many rapid and incoördinated movements.[6]

VI. QUANTITATIVE ANALYSIS OF THE DATA

1. Constant time interval. By referring to figure 3, which is the curve for twenty-four hour recess interval practice, it can be seen that this curve is readily divisible into two distinct parts. The first part begins with the first circuit and continues until it strikes the straight line of the second part. As indicated on previous pages, the first part of the curve we have called the

[5] It is this failure to distinguish between a coördination and random movements which, in our own opinion, constitutes the chief objection to Thorndike's conception of motor learning. A growth in coördination is in no sense a perseveration of certain random movements: it is essentially a synthesis of past efforts where inequalities cancel each other.

[6] An excellent illustration of the sudden appearance of new movements in an overstimulated pattern or one with very low endurance capacity is afforded in the behavior of maniacal patients. As is well known by careful observers, the supreme difficulty encountered in handling these patients is due to the sudden appearance of new movements—they break away from one's grasp—and not at all to the great energy they show. The encounter for the patient involves the breakdown of patterns of coördination and the emergence of random movements.

adaptation portion, and the second, the facilitation portion. Beginning with the sixth circuit of the twenty-four hour practice and continuing to the end of practice—we have carried this to over two hundred circuits with small groups—it will be seen that a straight line will smooth all of the points when they are plotted on double logarithmic paper. This means that the equation of this portion of the curve is of the type $C = Bx^n$, where C is the height of any ordinate or, in other words, the endurance capacity of the pattern at any point; B is a constant which can be read on the initial ordinate; n is a constant referring to the slope of the line on logarithmic paper; and x indicates the number of the circuit. In the once-per-day curve, $B = 12.6$ and $n = 0.25$. The curves for all constant interval practices—we have studied twenty-four hours, one hour, ten minutes, two minutes and one minute—reach this same facilitation line and proceed indefinitely toward the right at the same slope; however, they do not reach the facilitation line at the same point. The one minute curve reaches the line at the thirtieth circuit, while the twenty-four hour curve reaches the line at the sixth circuit.

If logs are taken of the equation

$$C = Bx^n, \tag{1}$$

we have

$$\text{Log } C = \log B + \text{n} \log x \tag{2}$$

which is seen to be the equation of a straight line in logs, where $\log B$ is the added constant and n the slope. The stations plotted in figure 3 are the medians taken from table 2. To avoid confusion, the first and third quartile points are not plotted in the figure but, when plotted, they also give straight lines which are parallel to the median line shown in the graph.[7]

[7] Tables of residuals as checks on the validity of our determination of the line of the medians and the constants are not given, since these can be so readily verified by inspection of our log graphs. The constants were determined by the method of simultaneous equations. The data are divided into two equal parts and for each is formed an equation in log form with the same B and n constants; from these, using logs of scores and stations, the constants are found algebraically.

The adaptation portion of our curve does not admit of such simple mathematical methods as shown above. In the twenty-four hour curve, the adaptation portion is very close to linear, but in all other types of practice it departs widely from this form. At present it does not appear to us that much can come from a study of the equation of the adaptation portion of the curve, and for this reason we have given it little attention. As a clinical device, the *B* constant seems to furnish all that could come from an equation of the adaptation curve. It represents the upper limit of growth in pattern formation, less the increment coming from facilitation during the adaptation period; and, since it is a constant, barring the wave motion factor to be discussed later, it serves as a perpetual measure of the functional capacity of these growth or adaptational patterns. However, *initial* adaptation, measured from the first few circuits, differs from what we get with the *B* constant. In certain clinical subjects the initial adaptation may be greatly depressed, while the *B* score is normal. This will be taken up later.

2. Mixed or broken practice. When mixed or broken practices are used, such as groups of twenty circuits with an intra-group interval of one-minute and a recess of twenty-four hours between groups (see curve A, fig. 4), there is a depression factor which follows the long recess. As pointed out in the preceding pages, this may lead to a *B* constant lower than that for constant intervals, in case the intra-group interval is as short as one minute and the group not longer than twenty circuits. A device other than the one presented for constant interval practice, must be used for determining the facilitation line in such practice. The depression is soon eliminated by practice and, it would seem, should be given little or no weight in determining the facilitation line in such practice. In our clinical work we often use the amount of the depression below the facilitation line to study pathological types, but the line must be determined independently of the depression to make this possible. We have found the median of a group of circuits the best representative measure of the efficiency of that group. When twenty circuits are used and the median for this group is

set on the appropriate ordinate on long paper, a facilitation line is found which is parallel to that for constant interval practice. As previously shown, the B score will be the same as for the constant interval under certain conditions, but under the conditions operating in the practice shown in figure 3, the B score falls to *11.5* for a normal group, as compared with *12.6* for the normal constant in constant interval practice.[8]

3. Constancy of n for all subjects. We have already indicated that the facilitation lines for all types of practice are parallel on log paper, which means that the slopes of the log equations are equal.[9] From this it would be a good guess that all individuals, whether high or low in efficiency, might have the same slope for their facilitation lines. This turns out to be the case and n, which is equal to *0.25*, is the universal slope. We have studied about *300* children, *500* insane, and over *1000* low, normal and superior adults among college students, and have invariably found the same average slope of the log equation in facilitation practice. It is of interest that many of our insane

[8] The advantages attaching to the use of an intra-group interval of one minute, as against two minutes, which gives the B constant of *12.6* lie largely in the saving of time, since after the first day's practice, a group of twenty circuits can be run off in thirty minutes. Up to the present time no disadvantages have been encountered in the use of the lower constant. The device lends itself readily to all sorts of clinical studies. The effect of drugs, wave motion in pathological cases, and the effects of menstruation, are some of the types of research we have carried out through the use of this type of practice. It is worth noting that the use of the median score in practices of twenty circuits with an intra-group interval of one minute gives a facilitation line which is not affected by the introduction of time intervals between groups as long as six months.

[9] It must be kept in mind that the slopes of the coördinate equation $C = Bx^n$ are not constant, as can be readily seen by differentiation: the x variable appears in the derivative, which indicates change of slope at each point studied. The constant slope of the facilitation line holds only for the log equation or, what amounts to the same thing, the plot of coördinate points on log paper. It is worth noting that the exponent n, while a constant, is not the slope in the coördinate equation; but it is the slope in the log equation, since it there becomes the coefficient of x, as $\log C = \log B + n \log x$.

subjects are well below the normal distribution curve for adults, and yet these have the same slope n. In our study of children of all age levels the slope of the facilitation line is seen to be the same as for normal adults. This constancy of the slope of the log equations for all subjects is not only a thing of much interest mathematically and physiologically, but it simplifies enormously the mathematics involved in the treatment of clinical data. Individual differences and wave motion phenomena can be analyzed most readily.

4. Significance of the B scores. The log equations for facilitation practice show, as indicated above, constant slopes for all subjects and all types of practice; consequently, the only term left to show individual differences is the B constant. The B score varies from individual to individual, and in the same individual from time to time; it is only the smoothed facilitation line which gives a constant, and then only for certain ranges of data under observation. It is well to note that the evidence favors variation from time to time in the B score rather than in n. When the same slope holds for all subjects, it is inconceivable that the slope factor would vary from time to time in any one subject to give rise to changes in efficiency. The B score, which we have defined as the functional capacity of a pattern built up by adaptational growth processes to the point where all future changes will be of a constant character—as in facilitation—is clearly the term which would vary. In the log form of our equation, the term $\log B$ may then be regarded as a measure of the functional capacity of this pattern to endure stimulation, and $n \log x$, as a constant increment—from subject to subject—due to facilitation; in which case, the B term becomes a variable factor, varying from subject to subject, and with every change of state of the adaptational pattern in any one subject.

The B score has the same meaning at all points within the facilitation practice. This is readily seen from curve A, figure 4. Here the median C score $\left(\frac{1000}{T+E}\right)$ is found for each of one hundred subjects in a practice of twenty circuits per day, circuits being separated by one-minute intervals. These

median scores for each day are thrown into a distribution and the quartile points found and set on the appropriate ordinate for the different days of practice. The first and third quartile lines are parallel to the median line, that is they have constant B scores, on the average, throughout the successive days of practice; and no constriction or change of slope is found as

TABLE 4

*Distribution of 750 B scores from 250 college students**

CLASS INTERVAL	FREQUENCY
17–17.9	3
16–16.9	11
15–15.9	11
14–14.9	38
13–13.9	106
12–12.9	130
11–11.9	150
10–10.9	128
9–9.9	101
8–8.9	40
7–7.9	22
6–6.9	10

Mean = 11.5
Median = 11.5
S.D. = 2

* Each subject does twenty circuits—one-minute interval between circuits—in each day's practice. The twenty circuits are arranged in serial order and the median found. From this median score, representative of the day's practice, the *B* score is found for each subject. The table presents the *B* scores for the second, third and fourth days of practice for each of 250 college students.

practice continues. This indicates that the deviations of the log scores are constant at all levels of the facilitation curve. Standard deviations of the logs of these median *C* scores also average a constant; also standard deviations of the *B* scores found for the median *C* scores average a constant. This last is the procedure followed throughout our clinical studies, that

is, the *B* score is found for each median *C* score; and this gives us a score free from the effects of practice.[10]

Table 4 shows the distribution of 750 *B* scores gathered from three days of practice from each of 250 college students. The students were equally divided as to sex and were drawn from all four college classes, with students from the sophomore class predominating. These standards have been found most satisfactory for studying college students, but are too high for adults of the general population; yet not so great a disproportion exists here as in intelligence tests. These standards have been used with adults of the general population for purposes of clinical study, where only extreme deviations are of interest.[11]

VII. ANALYSIS OF STABILITY

1. The B score as a measure of stability. The *B* score can be defined as the basic endurance capacity score, or the measure of the functional capacity of a sensori-motor pattern built up by growth processes to the point where it undergoes, through repetition alone, a measurable and predictable set of changes called facilitation. As we have indicated, this capacity varies from time to time. In other words, the *B* score becomes a measure of the *stability* of the sensori-motor pattern involved in this type of coördination. We believe that it will be apparent

[10] This can be readily done by means of the graph on log paper, which gives fairly accurate results, or by means of the ratio method, which is the one usually employed by us. This method depends upon the constant ratio of points forming parallel lines on log paper. The formula is: individual *C* score is to median *C* score as individual *B* score is to median *B* score. The denominators are read from a table and the computation carried out with one set of a slide rule.

[11] It is worth noting that our findings regarding the *B* score as the basis of individual differences, as well as our development of the equation, are basic for Thorndike's contentions regarding innate capacity, and his further point that practice increases individual differences. A careful analysis of our data will show that individual differences cannot be reduced solely to experience: a basic capacity of some nature is necessary. This last we show varies with every change of state in the functional capacity of the adaptational mechanisms which gives rise to the phenomenon of wave motion.

to anyone who has followed the analysis thus far, that this measure of stability must have great clinical significance. However, it is well to keep in mind, that it measures one kind of stability, namely, that of a particular sensori-motor apparatus and, while this function enters largely into many situations in life, it is not a general function and involves no general stability.

The author's six years of experience with this as a test of stability in a psychological clinic has convinced him that every ability has its stability or endurance capacity aspect, and that here we are dealing with the stability aspect of *one* of the most widely used coördinations; more cannot and ought not be said. Our analyses of hundreds of psychopathic cases point to the fact that the chief cause underlying these losses of coördination goes back to toxic or abnormal glandular factors. Most toxic states which strike the coördinations built up in the higher nervous system also strike the apparatus upon which this coördination rests; and this is without doubt the basis of our success in studying the behavior of many psychopathic conditions. However, it is both wise and expedient to recognize the fact that some extreme psychopathies exist which are independent of the coördination studied here.[12]

2. Physiology of stability. It is too early in the development of this type of study to venture a serious analysis of what happens physiologically in the adaptation and facilitation portions of the learning curve, but no harm can come from a tentative ordering of the field for purposes of orientation. It seems to the writer, as often noted in these pages, that in *adaptation* we are dealing with actual growth of new pattern which arises according to processes similar, possibly, to the stimulo-taxis conceptions of Dercum[13] and Kappers.[14]

[12] The author is convinced that the greatest danger facing the application of experiment to the clinical field lies in the tendency to premature generalization. The applications of the Binet tests and the conceptions of Freud to the clinical field are cases in point.

[13] Dercum, F. X. The Physiology of Mind. W. B. Saunders Co. Philadelphia, 1925.

[14] Kappers, A. Phenomena of neurobiotoxis in the central nervous system. Folia Neuro-Biologica, 1913, vol. 7, pp. 55–56.

In *facilitation*, we are dealing with something comparable, perhaps, to condensation of this pattern. There is, of course, facilitation taking place from the very first circuit of the instrument, but this is mixed with growth factors in all pre-facilitation stages of the learning. The term condensation is intended to point to some type of molecular rearrangement, comparable in a remote way, perhaps, to what takes place in a rubber band which is undergoing stretching. It is interesting to note that the equation connecting the weight applied and the amount of elongation of a thin rubber band is of exactly the same type as that for our facilitation curve. The pressure-volume relations of a gas may also be put in this form. The adiabatic gas law is usually stated in just this form.

It is our opinion that of the two stages of the learning curve, adaptation and facilitation, the latter is much more clearly reducible to mechanical processes than the former. The former involves that enormously complex series of processes taking place in growth itself. The writer is of the opinion that these processes are initiated by some stimulus, as provided in Kapper's conceptions; but that they continue through the time interval to complete changes and processes started by the stimulus, must also be considered. There is no evidence that patterns once built up are ever lost, but that they change from time to time in endurance capacity is one of the basic findings of this investigation. The causes of the regular circuit-to-circuit waves are unknown but prolonged changes in condensation seem to depend, in our experience, upon toxic and emotional or shock factors.

3. Wave motion phenomena. At no point in the study of this coördination does the mathematical analysis of the function give us greater insight than in the study of wave motion. We shall confine our treatment to the analysis of wave motion in the facilitation portion of the learning curve. In curve A, figure 4, it will be seen that the deviations in logs are constant at all levels of the learning curve. Standard deviations of the logs of the scores also average a constant for the various levels of the facilitation part of the learning curve. Probably the

simplest way to interpret this comes through the fact that constant deviations in logs of scores as shown in the learning curve means a constant relation between size of score and the amount of deviation; in other words, the deviation is a constant percentage, on the average, of the size of the score. This holds, as would be expected, not only for distributions, as shown in the graph, but also for the average wave motion of individuals from circuit to circuit; and this when the deviation or wave motion is determined by any device whatsoever.

It is a simple matter to find the wave motion of individuals through use of the smoothed facilitation line for each subject. Deviations for scores above the line are determined by finding the percentage of the actual to the smoothed score; and for scores below the line, by the percentage of the smoothed to the actual score. These percentages will average a constant for all levels of the distribution curve. Certain individuals will have greater wave motion than others, as would be expected, but when a large group of subjects is studied by being arranged in ascending series, according to size of score, it is found that the average wave motion, as expressed in percentage of mean score, is constant for the different quarters of the group; that is, the wave motion is, on the average, a constant percentage of the size of the score. In absolute value, it is greater for the large than for the small scores. This holds for both our raw scores $(T + E)$, and our conductance scores $\left(\frac{1000}{T + E}\right)$. Thus it will be seen that the highest wave motion—actual, not percentage—in conducting capacity falls to the most efficient subjects, while the highest wave motion in raw scores falls to the most inefficient subject. On a percentage basis, wave motion is, of course, equal for our conductance and resistance scores.

The wave motion depends also upon the conditions of practice. When constant time intervals are used the average wave motion is fairly constant for a certain range of intervals. Thus, in intervals from one to ten minutes in length, the average wave motion is 12 per cent of the score. For constant intervals of one day the wave motion is 15 per cent of the score. The wave

motion for series practice is the highest found in our experience, and in our study of 110 subjects the average wave motion was 20 per cent of the size of the score. In all of the above cases the wave motion is the average ratio of the actual scores above the smoothed facilitation line to the scores on the line.

When subjects with high percentage wave motion, computed as above, are isolated from the group for special study, it appears that there is a positive correlation between size of wave motion and pathological nature of the subject, as determined from his history. However, this is considerably less than the large negative correlation to be found between the *B* score and the pathological nature of the subject, and also between the *B* scores and the effect of drugs and other depressant factors.[15] These studies, as well as our quantitative analysis of data from clinical subjects, must be reserved for more extended treatment in later articles.

Correlational studies also throw considerable light upon these wave motion phenomena and also upon the utility of our measures of stability. When correlations are found between totals or averages of circuits made on the same day they run fairly high. In one group of one hundred subjects, in a practice of twenty circuits per day with one minute intervals between

[15] In general there is marked agreement between the findings recently reported by Hollingworth (Journal of Experimental Psychology, Vol. VIII, pp. 190–209) and our own. However, the present writer is unable to attach much meaning to Dr. Hollingworth's correlations between stability indices (reducible as we take it to wave motion in the present study) and the effects of alcohol, for example. A large group, studied, as we have ours, by means of wave motion from a central smoothed score, will not give, in our experience, a good correlation between wave motion and the effect of alcohol; but there is a fine correlation between performance ability and resistance to alcohol, as pointed out by Dr. Hollingworth. However, our lack of agreement may depend upon fundamental differences between our wave motion and his stability index, which we have regarded as properly reducible to the same thing. It is worth noting that our *B* score is the basis of our stability index, while Hollingworth differentiates between performance capacity and stability index. With us stability is endurance capacity; with him it is a phase of variability.

circuits, the correlation between the sum of the eleventh to fifteenth and sixteenth to twentieth circuits in each day's practice, ranges from *0.75* to *0.90*, with an average of *0.85* ± *0.003*. When the correlations between *B* scores of the same one hundred subjects,—each *B* score being derived from the median *C* score of a group of twenty circuits with inter-group intervals of one day,—are found for successive days, they range from *0.60* to *0.75*, with an average of *0.67* ± *0.01*. The drop in the correlation between *B* scores for successive days is no doubt due to the appearance of variations in physical state, which change the endurance capacity from day to day. The menstrual period in the females is a case in point and will account for some of our drop. When averages or totals of successive days are used correlations are of course increased. In a group of 80 subjects in a one-circuit-per-day practice, the correlation between the sum of the eleventh to fifteenth and sixteenth to twentieth circuits is *0.92* ± *0.006*. It is well worth noting that in a study of stability from day to day the utility of the scores does not rest solely upon a high degree of self correlation. If averages of many days are used, one of the most desirable insights into the clinical nature of subjects is obscured.

There is no question but that initial adaptability, as measured by the earlier circuits of the practice, must be considered as a separate function from stability, as measured by the *B* score. Correlations between initial adaptability and stability for groups of one hundred college students will average about *.40;* and this is true when the self correlation in the facilitation, or stability, levels is over *0.80*.

4. Emotional states. These states are so closely connected with stability or capacity to endure stimulation that it can be said that a vast majority, probably 90 per cent, of low stabilities are of the highly emotional type. This is not because they are so variable from moment to moment, as is usually supposed to be the case with these types, but rather in our experience, because of low basic capacity to endure stimulation. As would be judged from our analysis of wave motion, we are convinced that emotional subjects in general do not vary more than

normal subjects, when wave motion is considered as a percentage of the score; rather, it is a case of their falling to a low level before certain stimuli, and to a level more nearly normal in other cases. This does not mean that they vary more than do normal subjects when facing one specific source of stimulation. However, it can be seen that a subject who falls to a low level in this coördination has a very extensive nervous apparatus, the one underlying this function, sensitive to the presence of toxin or, through heredity, capable of only a low resistance to stimulation. It is upon this that our diagnosis of general emotional types depends. If the coördination we are studying were less extensive, our diagnosis of general emotional instability would have small utility.

Our findings seem to support the Dewey conception that emotions are breakdown phenomena, which present the picture of coördinations functioning with lowered efficiency. The conception that the neuromuscular systems which underlie these coördinations are sensitive to the presence of toxins, comes from our general clinical experience and from the additional fact that, as our research seems to show, these coördinations are simply built-up neuromuscular patterns, with variable capacity to endure stimulation. We are convinced that the popular conception, that coördinations are dependent upon the formation of connections, has slight utility unless these connections are conceived as bonds with variable capacities to conduct. This variability would seem to involve a ready tendency to be depressed.[16]

5. Sex differences. In our earlier studies of this coördination, we were much impressed by the sex differences obtaining in initial portions of the practice. The female college student was found to be superior to the male in initial adaptability. This is so great that, when unselected groups of one hundred of

[16] The best discussion of this nature of nervous coördinations we find in Henry Head's analysis of "Vigilance—Conceptions of Nervous and Mental Energy," Brit. Jour. Psych., 1923. We are not interested in his notion of vigilance but wish merely to recommend the article as an excellent discussion of certain neglected phases of nervous function.

each sex are studied, the experimental coefficient, McCall's device for showing reliability of a difference, will average in the neighborhood of *1.6*, indicating a difference too great to be due to chance. We have usually used the sum of the sixth to tenth circuits, inclusive, or the fifth circuit in serial order, to determine this adaptability. Earlier portions of the curve cannot be used since, at such points, the standard deviation is too large to give a reliable difference.

The differences shown above for adaptation disappear as soon as the facilitation level of the curve is reached. This would seem to point to the fact that our differences were due either to fundamental differences in adaptation or to experience factors.[17] We have not the space to go into the merits of this question, but it may be worth stating that the author believes the sex differences in the adaptation portions of the curve go back to fundamental differences in adaptive capacity. When children of various ages are studied, it is found that the sex difference does not appear until after pubescence. This does not settle the matter, of course, since some would contend that the female's extensive experience with the mirror begins at about that time. However, if there is a carry-over from this general use of the mirror to our function, it is not evident in the results of large numbers of psychopathic females who, though ardent students of their own mirror images, give very much lower records for initial adaptability than for stability, as measured by their own facilitation scores. On the whole, the evidence is very convincing that the post-pubescent male has his initial adaptability depressed by some glandular factor associated with the coming of sexual maturity.

6. Relation to intelligence. This function has a very low correlation with any of the established measures of intelligence. The correlation is so low as to point very clearly to the fact that the two must be considered as almost completely independent of each other. Correlations between *B* scores and intelligence

[17] Our subjects are all inexperienced so far as use of any apparatus for studying mirror tracing is concerned. We refer here to the possibility of experience arising from the general use of the mirror.

scores, secured from *Army Alpha*, *Otis Higher*, *Mentimeter* and *Thurstone* tests, range from *0.20* to *0.25* with small probable errors. When initial adaptability is correlated with these measures of intelligence the correlation rises noticeably and then ranges from *0.30* to *0.38*. When children are measured by the Stanford-Binet, and the age factor held constant, the correlations with *B* score will average 0.20 ± 0.03, and with initial adaptability they rise to 0.37 ± 0.02.

The writer feels that the rise of correlation of intelligence with adaptability over that for stability grows out of the fact that subjects with low initial adaptability in this function are in general slow learners, and that the learning element enters somewhat in the tests. When maze learning is reduced to conditions of adequate control, the correlations for initial adaptability in the maze and in our coördination often rise as high as *0.75* for college students. When the *Army Beta* tests are given with modifications, involving verbal instructions and change of time, the correlations with initial adaptability average about *0.50*.

In order to throw more light upon initial adaptability, we have made a small study of aged subjects. In almost every case the standing of these subjects in adaptability is much lower than in stability, when both are compared with the same traits in our standard college group. This is so much the case in our studies that old age can be considered as involving lowered adaptability rather than lowered stability, although the latter is found in very advanced years. Individual difference seems to play a very large part in determining the time when lowered efficiency may be expected. Our data, 20 cases between 60 and 80 seem to point to the fact that extremely low adaptability is found more among males than females.

We have made a study of three hundred children and adolescents ranging in age from six to eighteen years. It is found that the normal child of six years has a stability about *65* per cent that of an adult; a child of ten has a stability *75* per cent that of an adult; and an adolescent of *eighteen* years has, on the average, adult stability.

VIII. STUDY OF TYPES

Space is not available here for a satisfactory study of clinical types. These will be presented in special studies later, but at present enough can be presented in brief form to show the possibilities of this type of research in the clinical field. We have studied stability in focal infection, the college student, menstruation, administration of alcohol and other drugs, and among patients in a mental hospital. A few of these will be discussed briefly.

1. College students. In our study of college students we have been interested in determining the lower limits of stability where college work could just be done. Our *B* scores have been turned into sigma index scores, or as we call them, *stability index* scores, where the normal is *100* and a deviation of one sigma from the mean is given *20* points on the index scale. College students with stability indices as low as *70*—this includes about *7* per cent of the college population as measured by us—can rarely do wholly satisfactory work. When satisfactory work is done under stability as low as this it will be found that the student is doing only part time work or is taking only specially favored subjects. As the higher classes are reached the unstable students more and more find niches adapted to them; the unstable freshman or sophomore is much lower in his class standing than students of the same stability in the senior class. Unstable students in college are not weeded out so rapidly by college standards as is the case with low standing in intelligence.

2. Menstruation. We have made a study of one hundred females with special attention to the fall in stability at the time of the menstrual period. There are enormous individual differences here, some normal college girls being brought to a near pathological level, while others are only slightly affected. Subjective symptoms and stability, while related, do not correlate highly. The period of maximum instability begins shortly before the first subjective symptoms appear, rises to a maximum and falls rapidly at the appearance of flow. The average college girl falls to *80* per cent of normal stability (*St. Index 72*) at the time of her greatest menstrual disturbance.

3. Patients in a mental hospital.[18] Aside from our work with college students, our most extensive application of this experiment to clinical fields has been the study of patients in a state mental hospital. Here about five hundred insane were studied for stability. Deviations from normal are very marked. Less than 1 per cent of college students are as low as the median stability in a state mental hospital. The high 10 per cent of adults in a state hospital will average in stability slightly lower than eight-year-old children. The highest instability we found among dements (terminal form, not praecox); and here we saw the clinical picture of extreme old age, where the adaptability is depressed much more than stability. Wave motion in stability parallels change of state in all forms of intermittent or circular insanity, and may be used to predict oncoming changes. The highest stability is found among a small class of dementia praecox simplex patients. A few of these patients, though very low in adaptability, were normal in stability.

IX. SUMMARY

In this study of mirror tracing with an instrument of our own design, called the stabilimeter, we have attempted an analysis of the learning curve under various conditions of practice; have studied the influence of the time interval upon the learning process; have made an analysis of individual differences and have attempted an application of these findings to the clinical field. The learning curve has been divided into two parts, an *adaptation* portion, which begins with the first circuit of the instrument and continues for a variable number of circuits; and a *facilitation* part, which begins at the end of the adaptation part and continues indefinitely. During the adaptation stage of the

[18] Our study of the patients in a state mental hospital was carried out at the Utah State Hospital at Provo, Utah. We are greatly indebted to Dr. George E. Hyde, now deceased, former superintendent of the Utah institution, who urged that the investigation be undertaken there and who gave generously of this time in aiding our researches. We are also indebted to Dr. Frederick Dunn, present superintendent of the hospital, who has aided us in every way possible.

curve, the improvement has been shown to be a positive function of the length of the time intervals between circuits; in the facilitation stage, the improvement is a function of the number of repetitions. Improvement during adaptation has been interpreted as dependent upon growth processes leading to formation of neuromuscular pattern; while facilitation has been conceived as growing out of condensation of this pattern.

Scores are found from the time and error quantities. When improvement has become very slight, or is inhibited by special devices, the sum of the time and error quantities is shown to to be constant, i.e., $T + E = R$, for all variations of emphasis upon avoiding errors, from the point where $T = E$ to the point where $E = O$. R, in the last case, is the time taken to make a circuit with no errors; and $1/R = C$ becomes a measure of the endurance capacity of the patterns formed.

The equation of the facilitation function is of the form $C = Bx^n$, where C is the endurance capacity of the pattern at any point, and B and n are constants. The exponent, n, is found to be *0.25* for the facilitation level of the learning curve, and is constant for all subjects and all types of practice at this level. The B score, basic endurance capacity, may be readily determined, and forms the foundation for a study of stability; and, with the addition of a score for measuring adaptive capacity, a new device for studying clinical subjects is made available. Brief clinical studies have been presented from studies of college students and from patients in a state mental hospital.

TESTS FOR TRANSPORTATION PILOTS

A. J. SNOW

Northwestern University and Yellow Cab Company

Because a number of inquiries have been received, it is felt that it might be worth while to publish a brief statement of the tests that have been developed for transportation pilots. The tests are being standardized and applied, at this time, in the selection of taxicab drivers. However, it is felt that the psychological principles underlying the safe conduct of any transportation vehicle are the same whether it be a passenger or freight motor vehicle, a street car, a subway, an electric elevated line, a steam or electric railway.

While hoping that it would not be necessary to publish anything until the completion of the work, this publication has been forced because of the popular and misleading publicity that has appeared in the newspapers and magazines. We trust that it will be understood that this publicity has been a forced one—because of the unyielding demand of the industry. Another reason for the hesitation to publish any results is that the tests are still in the process of making. Even since the publication of parts of the tests for the purpose of illustrations in the recent book, Snow's "Psychology in Business Relations," it has been found advisable to modify the technique and apparatus.

This statement does not attempt to point out the technique used in the development of the test[1] nor the large body of material that has been collected up-to-date. All this, it is hoped, will be published in some monograph series when the work is completed.

The tests are used at this time for the selection of taxicab

[1] Snow, A. J., "Tests for Chauffeurs," Industrial Psychology, Vol. I, No. I.

drivers at the Yellow Cab Company of Chicago as well as in other taxicab companies in the following cities: Louisville, Cleveland, Pittsburgh, South Bend, Toledo, and Omaha. In Omaha the tests are being given by the Omaha Safety Council to any driver—automobile or street car—who wants to avail himself of the opportunity.

Up-to-date, in Chicago alone (Yellow Cab Company), twelve thousand applicants have been tested, of whom three thousand are at this time in the employ of the Company. The Company employs a total of six thousand drivers. The rejections, since January first, have been 15 per cent of all the applicants who have aspired to become Yellow Cab drivers. Rejections have been based upon the applicant's inability to pass the psychological tests satisfactorily. The reduction of accidents since January has been substantial.[2]

The following contains a very brief description of the tests used at this time:

MAJOR TESTS:

1. *Physical examination.* This examination is given by a physician and consists of a rigorous examination covering the usual fields such as the eyes, ears, reflexes, blood pressure, Wassermann, heart, lungs, etc.
2. *Intelligence tests.* The tests for intelligence consist of a group of very simple problems in printed form. The pamphlet which contains the tests includes also all the necessary directions and sample problems so that it can be given to a large group or individually without any oral instruction or interpretation except for the taking of the history of the subject. The tests require very little writing. We assume that the subject knows nothing (due to formal education) but what we attempt to teach him while he is taking the test. Of course he is expected to be able to follow very simple directions, be able to make marks and figures, and to copy letters.[3]

[2] *Ibid.*, pp. 40–44.

[3] For illustrations of the intelligence test, second revision, see Snow, A. J., Psychology in Business Relations, pp. 520–522. The tests as now used, however, have undergone still a third revision.

The time limit is twenty-five minutes. We attempt to measure the intelligence of the individual by the use of the following tests: (*a*) immediate and remote memory, (*b*) attention without distraction, (*c*) attention with distraction, (*d*) span of observation, (*e*) space perception, (*f*) imagery, (*g*) adaptability to unusual situations, (*h*) reason (common sense type), (*i*) learning, (*j*) speed of reaction, (*k*) perseverance.

This revision was of the following nature: (1) We reduced the time from twenty-five to fifteen minutes, obtaining the same distribution, both for the whole test and for parts of it. (2) We eliminated the printed general, introductory instructions and now give these orally, the reason being that since the value of the test is entirely dependent on the subject's understanding of what he is to do, we can better check up on this understanding when the instructions are oral. Our criterion for the giving of instructions is, can the subject *demonstrate* an understanding of what he is to do? (3) We have changed the type of "sample problem." We found that many subjects failed to profit by the usual presentation of the "sample problem" such as the following:

Sample:

Write on the dotted line the name of the automobile that can be spelled with the following letters: DORF.....ford.....

Consequently we changed them to the following type:

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8. Write on the dotted line the name of the automobile that can be spelled with these letters DORF.....
The name is FORD.

We tell the subject to read everything between the heavy lines, to avoid having him skip the answer. In this type of problem then, the subject gets a *motor reinforcement* to his learning, and very few fail to profit by the example. (4) We managed to still further spread out the low test scores. (The problem was to compound a test in which the lowest types of intelligence would be spread—differentiated—over as large an area as possible, so that it would be possible to choose carefully from among them.) With the revision, but 1.5 per cent receive 0 for a score. (5) Of course, from experience we were able to eliminate ambiguities and to balance up the test generally.

Theory: In our work, so far, we have discovered that average or superior intelligence is no index to a person's ability or inability to guide a vehicle safely—very low intelligence, however, invariably is an index.

3. *Emotional stability.*[4] Apparatus: The apparatus used in this test consists of an ordinary kitchen table placed in a dark room. The table is equipped with two independent electrical circuits, one, which we will call the X circuit, for the purpose of occupying the applicant's attention; the other, which we will call the Y circuit, is used to distract the subject. The X circuit consists of the following parts: two foot pedals, one hand switch, and two panels of lights, all in series. The lights on the two panels are in parallel, one panel being mounted on the table and the other outside the dark room on the experimenter's controlling board. The two pedals are controlled by the subject's feet while the hand switch is placed to the left of the panel containing the lights. In order to light the eight electric light bulbs the subject must place his two feet upon the foot pedals and bear down with his left hand on the switch while with his right hand he makes the appropriate connections on the panel, the process being very similar to that used on an ordinary telephone switch board.

The Y circuit consists of a bakelite board mounted

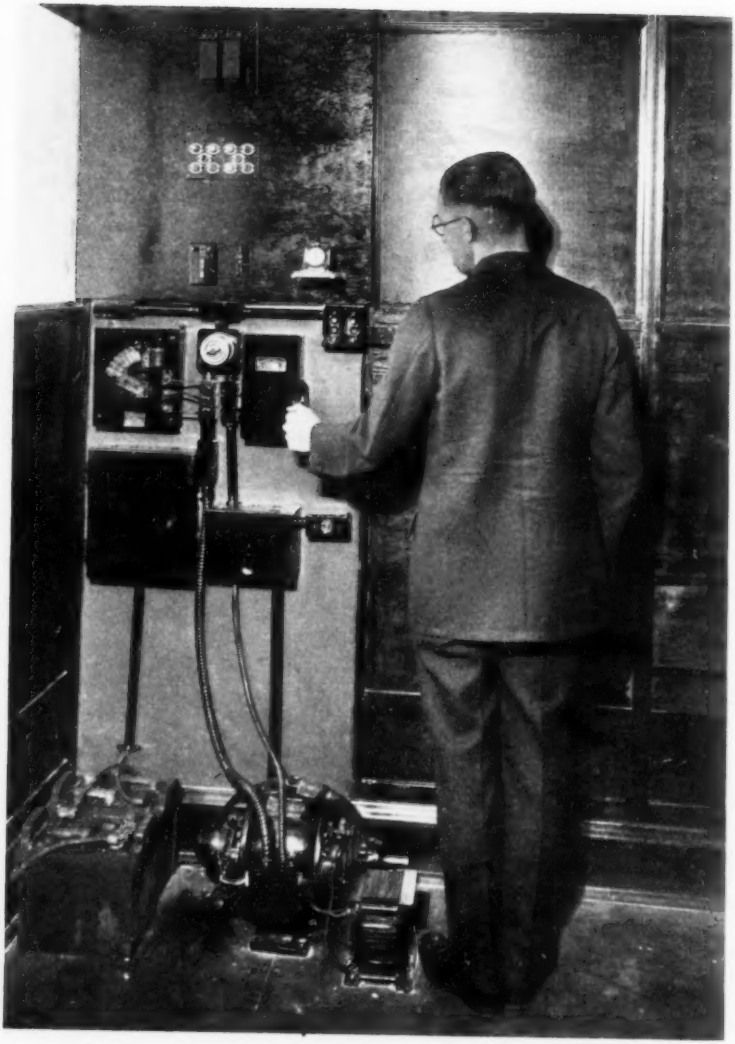
[4] For original test see *Ibid.*, pp. 535-536.

Our first idea, for this test, was found impracticable because of the large expense involved in the construction of the apparatus.

The idea was to have the prospective pilot demonstrate his ability to control a rapidly moving car. This "car" (seat and control) was to be suspended from a horizontal rail. The rail was to be inclined to a degree which would permit the "car" to develop a high rate of speed by means of gravity. In the construction of the support of the car there would be devised an automatic release which would, at a given moment, drop the "car" and the subject several feet. The attention of the subject would be controlled as well as his hands and feet. The subject would be instructed to stop his "car" at a given signal. The operation of the "car" as well as the controlling devices was to be automatic.

EMOTIONAL STABILITY TEST; APPLICANT IN PROPER POSITION

The two bulbs at either end of the table are not a part of the apparatus for this test. They are used in the Multiple Reaction-time Test.



CONTROL MECHANISM FOR EMOTIONAL STABILITY TEST
Mr. P. E. Hendricks operating

perpendicularly upon the top of the table and 10 inches in front of the subject's face. On this board are distributed electric wires which act as spark gaps and are controlled by a main switch outside of the dark room. One lead of wire (spark gaps) is extended in such a way that a shock can be administered to the subject's left hand. This Y circuit is in series not only with the main switch but also with two other switches which are in parallel—one controlled by the hand and the other by the foot and to the right of the subject. By the use of these last two named switches the subject can at any time intercept the flow of electric current in the Y circuit. The electric power for the Y circuit is transferred by the use of twelve ford coils, a high-frequency transformer (110–25,000 volts, 10 amperes), condenser, tesla coil and rotary spark gap. The reactions of the subject are automatically recorded by the use of a stop watch, which is in parallel with the Y circuit and is controlled by a set of relays and a magnet. The reactions within the body of the subject are recorded by the use of an ohmmeter and galvanometer.

Method. The subject is brought into the dark room and asked to sit in a chair facing the apparatus. He is told to place his two feet upon the two pedals of the X circuit and press down the switch of the same circuit. With his right hand, he is told to operate the small switch board of the X circuit—lighting the lights in order, one after the other. To do this the subject must, by a trial and error method, discover successively the terminals which will light the lights in the desired order. He is not only told to do this but he is also shown how to do it and he must *demonstrate* his understanding to the satisfaction of the experimenter. He is also told that if he should fail to light the lights in order (which always happens) he will "blow a fuse" creating a condition made up chiefly of a striking display of flashes of light. He is told that he must eliminate

this display, at once, by operating the hand and foot switches found to his right (this, as we have pointed out above, controls the flow of electric current through the Y circuit). Here, as before, the subject is told clearly what to do, the instructions are demonstrated, and he is made to *demonstrate* his understanding to the satisfaction of the experimenter. On the right arm of the subject is mounted a copper plate which terminates in the ohmmeter and galvanometer.

The subject is given to understand that the object of the test is to see how *fast* he can light the lights in the panel of the X circuit. At the same time, however, he is impressively told that if he should see anything unusual happen such as a flash of light or if he should feel a shock, he must shut the current off by operating the two switches to his right (Y circuit). The subject is instructed in semi-darkness, all of the apparatus being hidden from his view but the switches and the panel containing the electric light bulbs that he is to operate. When the test begins he is left in total darkness except for the meager light that comes from the small bulbs which, incidentally, are painted black.

This test consists of two parts:

A. Reaction time during fear: In this part of the test the experimenter permits the subject (after he has been left in the dark room) to light three to five lights and then he administers the shock and the disturbances created by the Y circuit. The subject intercepts the flow of current as rapidly as he can by the use of the two switches to his right. The time that has elapsed during the administration of the disturbance is recorded automatically by a stop watch; and the resistance as well as the change in electrical voltage in the subject's body is recorded on the ohmmeter and galvanometer. The experimenter, by the use of the corresponding panel of lights in the X circuit

outside the dark room, is able to check the movements of the subject, who must use his two hands and feet, as instructed, in order to be able to light the bulbs on the panel.

Theory: The theory underlying this part of the test is based upon the analogy drawn from the actual operation of a transportation vehicle. In this test, as in controlling the movements of a vehicle (the pilot's attention being held by the usual operation of the vehicle), the attention of the subject is held by his attempt to light the bulbs as directed. Then, suddenly, an emergency is created which disturbs the pilot—in this case, the subject, emotionally, and to which he must successfully react.

B. Emotional stability: In this part of the test the subject is under the same conditions as in the first part of the test with the exception that he is told to move his feet back on to the two pedals and his hand to the switch controlling the small electric light board (X circuit). He is told also to continue to light the bulbs as rapidly as he can. During this part of the test the subject is disturbed four times as in the first part, the difference simply being that the experimenter records very carefully the data supplied by the ohmmeter and galvanometer.[5]

[5] The results obtained by the use of the galvanometer are not altogether satisfactory because it is very difficult to control the movements of the subject. The results in the first part of the test (fear reaction) do not depend upon the disturbances recorded by the galvanometer but rather the time recorded by the automatically controlled stop watch. The whole problem of measuring emotional stability is a terrifically difficult one. While the use of the galvanometer has not been given up, experimental work in the measurement of the heart beat—speed, regularity, and volume—has been begun by the use of a plethysomograph and a hydrosphygmograph.

In as much as it has been a year since this article was submitted for

Theory: This test is based upon the theory that the record of an emotionally unstable individual will show a greater irregularity, increasing resistance and disturbance in the flow of electric current through his body.

4. *Recklessness.*[6] Apparatus: The apparatus consists of a small board on which are cut four irregular lanes. They vary in length and width, and begin and terminate at two common points. The first lane is the shortest but also the narrowest, the fourth the longest and widest. The lanes contain various obstructions—sharp turns, curves, and irregularities. The lanes are lined with metal strips through which flows the current from an automobile battery. In series with the board is a stylus which can be moved freely through the lanes. However, when it comes in contact with the sides of the lane, the circuit is closed, causing a slight disturbance in the body of the subject. Attached to this circuit is an automatic counter which records the number of times that the subject's stylus comes into contact with the sides of the lane.

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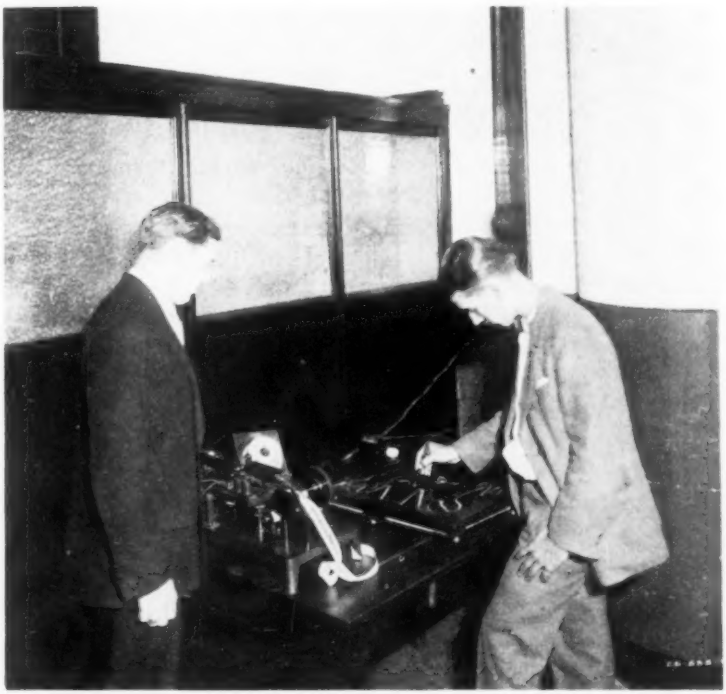
publication, the following changes in procedure have since been made: (1) It has been found better not to use the street analogy. We now simply say, "Move the stylus as rapidly and as carefully as you can through the lane," demonstrating our instructions, explaining that by care we mean "not touching the sides," and pointing to the stop-watch and counter. (2) Now, instead of allowing the subject to traverse the lane of his choice, we ask the subject his choice, record it, but require him to actually traverse the first lane, which is the widest and longest. (3) In place of the kymograph we now use an apparatus (see photograph), specially designed by Gaertner of Chicago, which combines all the recording—tuning fork, seconds, and contacts—on one sensitized tape, it being possible with this apparatus to get a record as much as twenty yards long. (While this apparatus is hidden from the subject's view, in order that the entire apparatus may be included in one picture we have here placed it on the table along side the lanes.)

[6] See *Ibid.*, pp. 541–542 for the description of the apparatus used in the first attempt to measure carelessness.

Underneath the board, containing the lanes, is another board of the same size containing a number of contact points. These points are so distributed that when the subject approaches and passes, with the stylus, any of the points of difficulty found in the lanes,



RECKLESSNESS TEST; APPLICANT IN PROPER POSITION
Mr. S. Roberts in charge

another electric circuit is completed, resulting in a movement of an electric tambour which registers upon a sensitized paper which is revolving around a kymograph. On the same paper, by the use of another circuit, which operates an electrically maintained tuning

fork, is recorded the time in fractions of seconds that it takes the subject to complete the test and also how long it takes him to move the stylus through the points of difficulty.[7]

Method: The subject is told to imagine that these lanes represent the conditions of the streets and that it is his task to move his car, which is now represented by the stylus, through any one of the lanes that he chooses, so that the motion of the stylus—which he now guides—should terminate at the other end of the lane. He is also told that the object of the test is to see *how rapidly he can move the stylus through the lane*, but that he must be *careful* not to touch the side of the lane as that would count against him. He is given to understand that if his stylus comes in contact with any one of the obstructions of the lane, that that would be parallel, in the analogy, with a collision on the streets. The subject is also told that the time it takes him to complete the movement is recorded by a stop-watch and that the number of "collisions" he has is recorded by the automatic counter.

As a matter of fact, the experimenter is interested only in the judgment which is involved in the selection of the lane that the subject desires to traverse, the data recorded on the kymograph. This part of the

[7] At first it was thought that it would be best to record the movements of the subject by the use of a pencil instead of a stylus. Instead of the use of the kymograph the record would be traced upon a uniformly moving paper (the motor being controlled by a governor) passing underneath the board containing the lanes. In order to designate upon this record the place where the subject passed through an obstruction a metallic plate would be placed underneath this moving paper. This plate would contain projections corresponding to the points of difficulty, so that when the subject traced the path of the lane with the pencil, an index of his approaching and passing through a point of difficulty would be registered upon the paper. One can easily see that this record would contain the rate of speed with which the subject moves the pencil through the lane.

recording apparatus is not visible to the subject nor does he know anything about it.

Theory: The theory underlying this test is that the careful driver will select the lane which permits him to make the best time with the least number or "accidents" and also that he will slow down considerably the movement of the stylus as he approaches and passes any points of difficulty found in his path. Of course the reduced time in passing a difficulty is always proportional to the time with which he moves the stylus between unobstructed points.

MINOR TESTS:

5. *Muscular fatigue.* Apparatus: Telegraph dispatching set and kymograph recorder as used in the recklessness test.

Method: The subject is told to tap as rapidly as he can upon the key for one minute. The horizontal position of the key is adjustable to such a height that the subject's forearm can rest comfortably on the platform which holds the key.

Theory: The theory underlying this test can be found in footnote (page 523) of Snow's "Psychology in Business Relations."

6. *Muscular Resistance.* Apparatus. A stiff steel spring mounted horizontally upon a board with a hand grip at the other end. Alongside this spring is a finely graduated scale.

Method: The subject is told to press the spring in a backward motion, exerting his maximum strength.

Theory: The theory underlying this test is to see if the subject can sustain a great deal of muscular strain. This is obtained by recording the time that elapses from the moment the spring is at the maximum contraction until it has been released one-third of its former distance.

7. *Simple and multiple reaction time.* Apparatus: Hipp's Chronoscope; Stimulus lights, vibrators, bell; Reaction keys and pedals.

Methods: This test has two parts:

A. In the first part the subject is told to react, by pressing a telegraph key, to a light, sound, and touch stimulus, as given by the experimenter. Reaction time is recorded on the chronoscope.

B. In the second part the subject is asked to respond, by the use of pedals and keys, to the various signals which are given by the experimenter, disregarding any other and distracting signals which may be given from time to time. Reaction time is recorded on the chronoscope, and the number of errors is counted.

Theory: The theory underlying the first part of the test is based on the assumption that the subject whose reaction time is slower, and more irregular than the average is a worse "accident risk" than the subject of normal and uniform reaction time. In the second part of the test the subject's reaction time as well as the number of errors made is an index to his ability to pay attention to the safe conduct of his vehicle in spite of the usual distractions of the road.

8. *Perception of space and motion.* Apparatus: Mounted upon a board 20 feet long are two toy vehicles whose motion is controlled by a system of pulleys and weights. Stop watch. Fixed scale of numbers three inches apart along tracks.

Method: The subject stands fifteen feet from the apparatus and facing it. The vehicles are moved at different speeds in various directions, according to eight different, prearranged combinations. The subject is asked at a given signal to indicate at what point the two cars will pass or overtake one another. The experimenter records the error between the subject's estimate and the actual point of passing. Experimenter also records rapidity and regularity of response, speed of learning, and constancy of attention.

Theory: The theory underlying this test is that the subject who is unable, with any degree of accuracy or promptness, to make the necessary judgment suffers from a visual defect—whether central or peripheral—which of course makes the subject an undesirable candidate for a pilot of any transportation vehicle.

Of course it is understood that for each test a learning period has been established. Our standard in giving instructions is to explain them in the learning period until the applicant can *demonstrate* to us an understanding of them.

In conclusion the reader is warned against any undue feeling of satisfaction because of the apparent success of the tests. It is too early as yet to tell with absolute certainty whether the problem of the selection of pilots has been adequately solved.

The work at the present moment is hindered by a great number of practical business difficulties, principally labor market. In spite of this, however, the work is very promising and only the future will tell whether it will be lasting or not.

(Manuscript received April 28, 1925).

INTELLIGENCE AND THE HEIGHT-WEIGHT RATIO

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There has always been a certain interest, both popular and scientific, in the question of possible relationships between the physical and the so-called mental traits. One of the most recent and original attacks upon this problem has been made by Naccarati (2), who obtained positive correlations between intelligence scores and two indices of morphologic type: (*a*) the *morphologic index*, an elaborate measure which gives the ratio of length of limb to trunk volume; and (*b*) the *height-weight ratio*, a more simply obtained indication of the same fact. Of the two measures, the morphologic index is the more precise and commonly gives higher correlations with intelligence. The height-weight ratio, however, has the advantage of being easily obtained and the fact that it has given correlations of $+0.75 \pm 0.05$ and $+0.70 \pm 0.04$ with the morphologic index (2) makes it acceptable as a fairly reliable substitute for the latter. Furthermore, it too has given positive correlations with intelligence.

These correlations Naccarati regards as indicative of a relation between intelligence and morphologic type such that the higher levels of intelligence tend to accompany the microsplanchnic type, whereas the lower levels are more likely to appear in the opposite type, the macrosplanchnic. As Naccarati uses the terms, *microsplanchnic* refers to individuals in whom the development of the limbs predominates over the development of the trunk; *macrosplanchnic* to those in whom the development of the trunk is proportionately greater than that of the limbs. Between the two he places the *normosplanchnic* type, which includes individuals in whom the development of limbs and trunk is proportionately balanced. No claim is made

for a perfect point for point correspondence between intelligence and morphologic type; in fact, Naccarati believes that neither extreme, morphologically considered, will be found to represent the highest levels of intelligence. His contention is only that, in a group as a whole, a general tendency will be found for greater intellectual activity to be present in individuals in whom the system underlying the activity of the limbs and extremities is dominant over that underlying the visceral and vegetative functions. His explanation of this condition is given in terms of the endocrine glands. He believes that the glands which make for the growth of the longitudinal diameters of the body are the same as those which make for activity of intelligence.

Naccarati's work deserves attention, not only because it represents a novel and promising line of attack upon an old and important problem, but because a considerable body of evidence has been brought forward in support of his theory. In his original publication (2), he presented positive correlations, some of them statistically valid, between scores in standard intelligence tests and his two measures of morphologic type; and in the same study, he reported the absence of significant correlations between intelligence and either height or weight taken separately as evidence supporting his general thesis that a complex activity like intelligence is not connected with a limited feature or aspect of the physical make-up, but with something which, like the glands, exerts a general influence on the organism as a whole. The groups which formed the basis of this study ranged in size from 50 to 221. In a follow-up study, made in collaboration with Lewy-Guinzburg (3), he confirmed the results of the earlier study; positive correlations, some of them substantial, were obtained between the height-weight ratio and the Alpha, Otis, and Thorndike tests. This investigation was based on groups of 50, 94, and 252. In a study made by Naccarati and Garrett (4), "to determine whether there is any relation between body growth and the speed and flexibility of the individual's mental and motor reactions," a comparison of two groups, one having high, the

other low morphologic indices, tended to show that "in speed and flexibility of mental and motor performances, as measured by cancellation, controlled association, and maze tracing, those individuals with high morphological indices surpass those with low indices." This conclusion, however, was regarded as tentative because of the size of the group, which included only 57 cases. The same study also brought out positive correlations between the height weight ratio and the Alpha, maze tracing, cancellation, and controlled association tests in groups of 50, 57 and 150. The general tendency of the evidence is to support the contention that there is an appreciable relationship between morphological type and intelligence.

The question of a possible relation between morphologic type and emotional reaction has also been investigated. Naccarati and Garrett, carrying their investigation into the field of temperament (5), found that individuals with low morphologic indices tend to be less stable emotionally than those with high morphologic indices, when emotional stability is measured by the Woodworth questionnaire. This result, too, they considered tentative, because of the size of the sample, which included 54 cases altogether and which was divided into three groups of 18, 16, and 20, representing high, medium, and low emotional stability respectively. In another study made by Naccarati (6), in which 100 psychoneurotics were used as subjects, it was discovered that the "asthenic" patients were more likely to be found among the microsplanchnics, the "emotional" among the macrosplanchnics. Landis, Gullette and Jacobsen (1), however, obtained results exactly the opposite of those of Naccarati and Garrett as regards emotional stability. They found negative correlations, averaging about -0.18, between the height-weight ratio and various criteria of emotionality, but because their group included only 25 cases, they did not attach great significance to this finding. On the whole, the trend of the evidence reported up to this time suggests that the morphologic index is a measure of a fairly definite condition which is connected with intellectual and emotional reactions in a manner which represents something more than chance.

In view of the uniformity with which Naccarati's results have been confirmed, it seems desirable to report a study in which the relation of intelligence to the height-weight ratio was tried out on a somewhat larger scale than that attempted in any of the studies which have appeared so far, and in which the general result has been a failure to obtain any evidence in support of Naccarati's conclusions.

The study in question was made at the University of Minnesota on 1000 native-born white students who entered the College of Science, Literature and the Arts in September, 1924. The selection within the class of entering freshmen, which numbered 1300, was purely alphabetical; the first 500 men and the first 500 women for whom both intelligence scores and measurements of height and weight had been obtained were used as the basis of the study.[1] It is important to note that the 1000 cases studied represented a large sampling of the entire group of 1300.

Height and weight measurements for the women were obtained from the Physical Education Department of the University and those for the men from the University Health Service. These measurements were made as a part of the general physical examination which is given by the members of these departments to all students entering the university. That is, the measurements were made by individuals who had received special training in that line and who had access to apparatus which gave precise and accurate results.

The intelligence scores were those secured in the regular University of Minnesota Entrance Examination which all students take as a part of the entrance routine. This examination is a group test consisting of five parts:

1. H. T. Moore's Completion Test.
2. An Arithmetical Reasoning Test, adapted from the Alpha Test.

[1] The writer wishes to thank Dr. J. Anna Norris, of the Physical Education Department, Dr. H. S. Diehl, of the University Health Service, and Prof. D. G. Paterson of the Psychology Department for access to the files from which the original data for this study were obtained.

3. An Opposites Test of the multiple choice type, prepared by the Psychology Department of the University of Minnesota.
4. A Reasoning Test, taken from the Psychological Examination published by the American Council on Education.
5. A Vocabulary Test, also of the multiple choice type and also prepared by the Psychology Department of the University of Minnesota.

A separate score is given for each test and a final score is determined for the test as a whole. In each component test, the raw scores are converted into percentile ranks which constitute the scores for that test. The final scores are obtained by averaging the percentile scores made by each individual in the five tests and redistributing these averages according to a percentile ranking.

In the present study, correlations were obtained between the height-weight ratio and the percentile scores in each of the five component tests and in the examination as a whole. All correlations were computed according to Pearson's product moment formula.

The reasons for considering this material particularly suitable as a means of testing Naccarati's conclusions are mainly three:

First, the subjects constituted a group considerably larger than any that Naccarati found available. On the whole, Naccarati's groups have been fairly small. The largest group in his original study numbered 221; in his work with Lewy-Guinzburg, his largest group included 252 subjects; and in his two studies with Garrett, his main groups were admittedly small, numbering 57 and 54 respectively, though a supplementary group of 150 was used as the basis of some of the correlations. Furthermore, his highest correlations have not been obtained in the largest groups. The correlations of $+0.35 \pm 0.06$ between the Thorndike test and the morphologic index (2) was obtained from a group of 75; the correlations of $+0.44 \pm 0.07$, $+0.37 \pm 0.08$ and $+0.31 \pm 0.08$ between morphologic type and controlled association, maze tracing, and Alpha respectively (4) were all obtained from groups of 57. The correlations of $+0.44 \pm 0.06$ between Alpha and the height-

weight ratio (3) was based on a group of 50. In the larger groups, the correlations were lower. The group of 221 gave a correlation of $+0.23 \pm 0.04$ between the Thorndike test and the height-weight ratio (2), and a correlation of $+0.13 \pm 0.04$ between the same measures was found in the group of 252 (3).

Second, the group used in the present study was presumably less selected on the basis of intelligence. The term "entrance examination" as applied to the Minnesota test is a misnomer if it implies that students are excluded on the basis of low scores. As a matter of fact, all applicants for entrance who are graduates of accredited high schools are admitted; the tests are given as a means of securing information which may be useful in administrative and personnel work. In other words, the lower end of the distribution is present in the freshman class and is represented in the group studied. Naccarati's groups were for the most part students at Columbia University, where the lower end of the distribution is excluded on the basis of entrance examination scores. In fact, Naccarati and Garrett report of one of their groups (5) that the average Alpha score was 170 and that only two of the 54 cases fell into the B group. At the University of Minnesota (7), the median Alpha score for freshmen women was 128; for freshmen men, 129; only 79.9 per cent of the men and 78.8 per cent of the women received A and B grades. This means that approximately 20 per cent of the entering students receive grades of C or lower. These results were obtained in 1918, but the results of intelligence tests given to successive freshmen classes from that year on, have given no indication of a change in the entering students as regards intelligence. On the other hand,there is no reason for believing that the upper end of the distribution is not represented at the University of Minnesota. The results of standard intelligence tests, given in various classes, include some very high scores as well as some relatively low ones. For example, Alpha scores of 200 and over occur with expected frequency. Unfortunately, direct comparisons of the experimental groups in question cannot be made because of differences in the tests employed, but the chances are that the groups used in the present study represent a wider range of intelligence than those used by Naccarati.

Third, the number of subjects made it possible to divide the group on the basis of sex and still have a large number of cases in each group. Several of Naccarati's groups include both men and women. However, where morphological type is concerned and where glandular factors may be involved, it is obvious that sex differences may be important. In fact, a sex difference in the height-weight ratio is indicated by the results of the present study. Specifically the results are as shown in table 1. That is, the women were distinctly higher in height-weight ratio than the men; the difference between the averages of the groups is 19.4 times the P.E. of the difference. To include the two sexes in the same group, therefore, might easily obscure an existing relation. Besides, a division of the group on the basis of sex might bring out sex differences which would not appear if the single group were taken as a whole.

TABLE 1

	AVERAGE H/W RATIO	$P.E._{av.}$	DIFF.	$P.E._{diff}$
Men	0.49615	0.00158		
Women	0.54310	0.00184	0.04695	0.00119

The principal statistical results of the study are given in table 2.

There is a marked discrepancy between these results and those obtained in the previously reported studies. The correlations tend to approximate zero and the probable errors are small as compared with those given in the other investigations. In other words, there is nothing in the evidence to indicate a significant relationship between intelligence and the height-weight ratio.

It should be noted, too, that a failure to confirm Naccarati's results occurs both in final scores and in scores for the component tests. If only the final score failed to indicate a significant relationship, the result might be attributed to some failure in this score to represent adequately the subject's performance,—possibly to an improper weighting of the component

tests, or the inclusion of one or more poor tests which tended to reduce the distribution to a chance arrangement. But the separate test scores and the final scores give consistent results. This, in turn, may simply mean that all the tests are inadequate as measures of intelligence, but this interpretation is improbable, since the tests used in the examination have been rather thoroughly tried out at Minnesota,—and some of them elsewhere,—and have been found satisfactory according to accepted standards. It is particularly interesting to note that some of the tests in the group,—the opposites test and the vocabulary test,—are similar to the controlled association

TABLE 2

Correlations between height-weight ratios and percentile scores in the tests indicated

TEST	MEN (500 CASES)		WOMEN (500 CASES)	
	r	P.E.$_r$	r	P.E.$_r$
Completion	−0.01	0.03	+0.05	0.03
Arithmetical reasoning	+0.01	0.03	−0.07	0.03
Opposites	+0.02	0.03	+0.06	0.03
Reasoning	+0.03	0.03	+0.04	0.03
Vocabulary	+0.10	0.03	+0.03	0.03
Final score	+0.03	0.03	+0.04	0.03

tests which Naccarati and Garrett (4) found to give a correlation of $+ 0.44 \pm 0.07$ with morphologic type, and that the arithmetical reasoning test was adapted from a similar test in the Alpha examination, which gave positive correlations with the height-weight ratio in several of the reported studies (2) (3) (4).

The failure to confirm Naccarati's results, however, does not mean that his conclusions have been disproved. Correlations approximating zero may be brought about by other factors than a chance relationship between the measures in question. Several possibilities must be considered.

First, the correlation may be reduced because the measures themselves are not precise. It is improbable, however, that this condition is an important factor in the present situation.

The estimated reliability of the final score in the entrance test is about .90. This estimate is based on a study of the tests, covering a period of four years, with freshman classes entering the university three times a year. High reliability is indicated by the uniformity of the results obtained from year to year (*a*) in correlations between final scores and scholarship, (*b*) in correlations between these tests and other intelligence tests, and (*c*) in intercorrelations between the component tests. Judged by similar standards, the coefficients of reliability of the component tests,—with the exception of the Reasoning test,—would not fall below .80, and probably only one, the Arithmetical Reasoning test, would fall as low as that. An exception is made of the Reasoning test because it was used for the first time in 1924 and has not been studied as have the others. The physical measures, too, doubtless possess high reliability as measures of height and weight, but perhaps it is well to call attention to the previously stated fact that the reliability of the height-weight ratio as a substitute for the morphologic index is indicated by its correlations of +0.70 and +0.75 with that measure. In his original study, Naccarati makes much of the precision with which the anthropometric measures used in computing the morphologic index must be taken. But in comparison with taking these measures, the determining of an individual's height and weight is a relatively simple matter. Besides, as has been pointed out before, these measurements were taken by persons with special training and in circumstances which would give greater accuracy than is found in most height and weight measurements.

Second, the correlation may be reduced because the group is selected. It is undoubtedly true that this group, like any university group, is selected on the basis of intelligence. Reasons have been given, however, to show that it is probably less selected than those used by Naccarati,—at least, that it is unlikely that it is more selected. But another factor of selection may be found in the morphologic type represented. In fact, Naccarati suggests that his groups are selected on that basis,—that there are no macrosplanchnics among his subjects;

that the tendency is toward the microsplanchnic type, and that, on the whole, his groups include "too many normosplanchnics." He believes that higher correlations with intelligence would be found if his groups were less selected in this respect. Whether the Minnesota group is more selected in morphologic type than Naccarati's may be indicated by comparing the groups in range, where the necessary data are available. Naccarati gives the range of two of his larger groups, which compare with those used in the present study as shown in table 3. Though the range is a rather unsatisfactory measure, it is the only one available, and it serves to indicate at least that the groups used in the present study are not less inclusive than those used by Naccarati.

TABLE 3

GROUPS	NUMBER OF CASES	RANGE IN H/W RATIO
In "The Morphologic Aspects of Intelligence" (men and women)	221	0.370 — 0.639
In "Hormones and Intelligence" (men)	252	0.321 — 0.640
In the present study (men)	500	0.318 — 0.706
In the present study (women)	500	0.332 — 0.772

Third, the correlation may be reduced because a common factor, though present, is offset by another factor working in the opposite direction, or hidden by a group of factors working in such a way that the influence of no one of them can be singled out. For example, in a study of the present sort, the sex factor might obscure the relationship between the two measures studied. If there were an existing relation between intelligence and the height-weight ratio in each sex, and if there were a large and significant difference between the sexes in one of these respects, as is actually the case with the height-weight ratio, the combining of the two groups and the application of the same standard to both might confuse the relation of the measures in question to such an extent that an existing relation would be concealed. However, this cause of confusion has been eliminated from the present study. Besides, an examination of the

data has failed to reveal indications of other factors which might operate in this way. But it must be recognized that this may only mean that the factors are so involved and intricate that the isolation of any one of them is impossible in the present conditions.

In conclusion, therefore, it can only be said that the present study has failed to bring out any evidence in support of Naccarati's conclusions,—not that his theory has been disproved. The number of cases, however, entitles the results to consideration as a negative instance. It is significant, too, that the conditions in which they were obtained were relatively favorable for this kind of study. The slighter degree of selection within the groups, as compared with those used in the other studies, the probable reliability of the tests, the isolation of the sex factor, and the absence of indications of other complicating factors, make it desirable to report results, which, in the conditions stated, differ from those hitherto obtained in studies of the same problem.

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A STUDY OF CERTAIN ASPECTS OF ADVERTISING IN THE SATURDAY EVENING POST

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This study includes the results of the investigation of several aspects of advertising in the *Saturday Evening Post*, as indicated by the headings of the three following sections, covering the period since 1900. The data were gathered on each topic from complete issues of the months of March, June, September, and December for the years 1900, 1905, 1910, 1915 and 1920, these months being taken as fairly representative of the advertising practice of the year. The advertisements appearing on the front and back covers were omitted from computation throughout the study.

I. INCREASE IN SIZE OF ADVERTISEMENTS, AND IN THE RATIO OF ADVERTISING TO READING SPACE

The data covering both points are given in table 1 in terms of percentages, and need little comment.

The average size, as given in the next to the last column, was found by dividing the total number of pages of advertisements for the year by the total number of individual advertisements of every size for the year. The percentages of the last column were obtained by comparing the amount of space given to advertisements with the total amount of space in the magazine, thus giving the advertising space ratio.

The steady increase in the use of the full-page advertisement is probably the most significant tendency indicated in the table. The double page spread shows a noteworthy jump in 1920, while the half-page size seems to be holding its own. The

smaller sizes are fast being eliminated from the *Post*, although they held a relatively important place even as late as 1910 and 1915. The recent development in the use of the double-page spread and the full-page size are largely accountable, no doubt, for the very large jump in the size of the average advertisement for 1920. The last column shows that the amount of space allotted to advertising is fast gaining over the amount allotted to reading matter. This fact raises the question as to the normal saturation point in magazine advertising which ought to be giving both publisher and advertiser some concern.

TABLE 1

Showing increase in size of advertisements and ratio of advertising to reading space

YEAR	DOUBLE-PAGE SPREAD	FULL PAGE	½ PAGE	⅓ PAGE	¼ PAGE	⅛ PAGE	⅙ PAGE	1 TO 5 INCHES	AVERAGE SIZE	ADVERTISING SPACE RATIO
	per cent	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*		*per cent*
1900	0	7.2	0	6.5	3.6	22.6	18.8	41.3	0.04	12.9
1905	1.0	17.1	0	2.4	2.8	27.6	15.7	33.4	0.10	37.1
1910	9.3	33.3	0.4	12.3	1.0	21.0	7.7	15.0	0.20	49.5
1915	9.2	44.7	0.3	13.3	2.4	19.3	5.6	5.2	0.19	49.0
1920	22.6	62.0	0	10.2	0	4.6	0.1	0.5	0.84	59.5

II. THE DEVELOPMENT IN THE USE OF ART-FORMS

This study may be considered an extension of the investigation of Kitson[1] to a new type of medium, the *Post*. The same classification as that employed by Kitson was used in the present case so that the data are directly comparable. The results are given in percentages in table 2.

The results show a marked and consistent decrease in the use of pen and ink drawings from about 64 per cent in 1900 to under 11 per cent in 1920. The drift from this type of illustration seems to have been not to any other pure type, but

[1] Jour. App. Psychol., March, 1922, 59.

to various forms of combination drawings as indicated by the consistent increase of the latter at a rate roughly comparable to the decrease in the use of the pen and ink type. The wash drawing shows little gain since 1905. The photo follows no consistent trend during the period. The pencil and charcoal types have never been used extensively since 1900. The increase in the use of a combination type may be explained very largely by the relatively enormous development in recent years in the use of color in magazine advertising.

TABLE 2

Showing tendencies in the use of art-forms in advertisements

YEAR	PENCIL	PEN AND INK	WASH	PHOTO	COMBINATION	CHARCOAL
	per cent	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*
1900	2.0	63.9	6.4	24.7	3.0	0
1905	0.3	36.0	30.9	15.1	16.8	0.9
1910	0.4	24.9	30.7	20.6	23.2	0.2
1915	1.2	15.1	25.9	26.3	31.5	0.0
1920	0.5	10.6	37.4	14.1	37.2	0.2

III. THE USE OF THE COUPON OF FULL-PAGE ADVERTISEMENTS

The data concerning the use of the coupon on the full page size is restricted to the years 1910, 1915 and 1920. In the issues selected for study, only 2 full page advertisements were found for 1900, and neither of these bore a coupon. In the issues for 1910 only 7 full page advertisements appeared, 2 of which carried coupons. These will be ignored in the comparisons that follow, which will be based on the other three years above mentioned.

There has been a marked decrease in the use of the coupon on advertisements of this size since 1910. For that year 23.6 per cent of this size contained coupons. This ratio was reduced to 9 per cent in 1915 and to 3.8 in 1920. Evidently the coupon is falling into disrepute among advertisers of the *Post* of the better class.

There appeared to be no trend over the period studied so far as size of coupon is concerned, and therefore the detailed

data secured on the area of each coupon are not given. Likewise the form of the coupon has undergone no decided change since 1910, the trangular shape being then, as now, the preferred one, with the rectangle a second choice.

Of the 119 coupons examined for the years 1910, 1915, and 1920 by far the larger number were located in the lower right right hand corner of the page, the corner in such cases being nearly always the loose outside one which permitted the coupon to be easily torn off. To be exact, 96 of the 119 held this position, 13 held the lower left hand corner position, also usually an outside corner. The remaining 10 were located at various points in the layout not easily described.

The length of the signature line was found to vary widely. Only 2 of the 119 examined were less than 1 inch, 46 were between 1 and 2 inches in length, 51 between 2 and 3 inches, and the remaining 20 between 3 and 4 inches. No significant difference appeared for any of the years studied.

The width of the signature space also varied widely as shown by the following distribution of the 119 cases:

Width of space	1/8	1/6	1/4	1/3	1/2	2/3	3/4
Number of cases	21	7	44	35	9	2	1

No tendency toward the use of a space of greater or less width appeared over the period.

The following table indicates the classes of products advertised in the full page size carrying a coupon:

Automobile and accessories	25
Toilet articles	14
Food products	14
Electric devices for home	10
Floor wax, varnish etc.	10
Home study courses	9
Musical instruments	7
Machinery	7
Office fixtures and supplies	6
Miscellaneous	17

Apparently the coupon is used in advertising smaller, cheaper articles, samples of which may be readily sent, or as a lead to direct mail advertising in connection with more important products.

THE SUITABILITY OF THE DOWNEY GROUP WILL-TEMPERAMENT TEST AS A TEST FOR CHILDREN

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The criticisms of the suitability of using the Downey Group Will-Temperament Test as a test for children of grammar school grades are an outgrowth of a study of racial differences based upon this test. Two hundred and eleven white and negro boys of the seventh and eighth grades of P. S. 119, Manhattan, New York City, were used as subjects. In addition to the test results, the writer secured the chronological ages and the I.Q.'s of the children. The results of white group only, which consisted of 110 children, will be discussed in this paper.

The average age and I.Q. scores, together with the standard deviation and the probable error of the average, are given in table 1.

Space will not permit of a complete discussion of the test. It will be sufficient, however, to recall that it consists of 12 different tests, based mostly on handwriting. Dr. Downey's book, "The Will-Temperament and Its Testing," or the Manual of Directions for the Group Will-Temperament Test, both published by the World Book Company, give a detailed analysis and description of the test. It must suffice here to merely enumerate the parts.

A. Speed of Movement, VI-1
B. Freedom from Load, VI-1, 2
C. Flexibility, VIII
D. Speed of Decision, I
E. Motor Impulsion, X
F. Self-Confidence, XI
G. Non-Compliance, XII

H. Finality of Judgment, XIII
I. Motor Inhibition, VII
J. Interest in Detail, IX
K. Coördination of Impulses, V
L. Volitional Perseveration, VIII-2

The writer, on the basis of the test results of the 110 white children, made a careful study of the responses to each test within the total test. The purpose of this careful and detailed study was to determine if the child was reacting to the test as he should in order to measure the trait under consideration.

As a general criticism of the test as a whole, it might be said that the handwriting habits of children are not firmly enough established to warrant the placing of too much dependence upon them. In fact, it is questionable if even the adult has a "usual" style and speed of writing. Great emphasis is placed upon the determination of the subject's normal speed as a

TABLE 1
Age and I.Q. scores

	AGES	I.Q. SCORES
Average	15.22	107.45
σ	1.03	18.85
P.E.	0.07	1.21

standard on which to judge other traits. But, most people have different styles which are normal for the different things that they are writing, i.e., they have a style and speed which is usually used for letter writing, another for note taking, another for writing notices, etc. The child, it is true, has not so many different opportunities to use different styles, but then too, his writing habits are not nearly so firmly established. In addition to this criticism, it may be added that the mental set established through previous contact with mental tests is one of speeding up to accomplish the most possible within a period of time. This mental set strongly militates against the possibility or probability of the child's writing in his usual school manner.

A careful analysis of the individual tests within the whole has brought out the following points of criticisms in each.

A. Speed of Movement, VI-1, as determined by the number of letters written at normal speed within the time limit. The mental set of a test situation seemed to be especially operative here with the result that the children as a whole seemed to be trying to write as much as possible within the allotted time. This was evidenced by the lack of perfection in the writing as compared with the writing of the name, age, grade, etc., on the fly-leaf of the booklet. Moreover, while the average number of letters formed during the 20-second period was only 45.50, or $2\frac{1}{2}$ per second, the range was from 21 to 168, showing undoubtably that some of the children were speeding up with the idea that the more they accomplished, the higher would be their score.

B. Freedom from Load, VI-1, 2. This is measured by finding the ratio between the number of letters written at normal speed and when writing as rapidly as one can. If a child had not given a specimen of his normal writing in the first part of the test, the ratio would then not be accurate and the results thus invalidated.

C. Flexibility, VIII. In the first part of the test, the subject is instructed to change his handwriting as much as possible so that no one would recognize it, and is judged by the amount of change. In the second part, he is told to imitate some handwriting as rapidly as possible, and the score is determined by the amount of change and the number of letters written in the given time. Children seemed to like this test very much, and they worked hard on it, especially the first part. But, the scoring offered many problems. What is the child's normal style? A study of the writing on the fly leaf, tests II and VI varied so greatly that it was almost impossible to obtain a standard. Also, the judgment based upon these records would as a result be so uncertain as to be little more than personal opinion. Copying the handwriting given in the second part of the test produced nothing of value. As a rule, the first two or three letters were well copied, but then the subject reverted

to his own style in an attempt to complete more work. In addition to this, the lack of complete control in writing made it impossible for the child to imitate so difficult a model as the one given. Although this proved to be one of the most interesting tests to the child, the results are worthless as far as an objective measurement of the trait of flexibility is concerned.

D. Speed of Decision, I. This trait is measured by the number of adjectives characterizing the individual which he marks in the given time. The results of this test seem to indicate that most of the children are not reacting to this test in exactly the way Dr. Downey meant them to react. They are making decisions in regard to the pairs of character traits listed, it is true, but their reactions suggest that they are checking the traits which are socially desirable rather than the ones which describe them. In giving the instructions, the examiner laid special emphasis on the point that the child must decide which word best described him, and not which he thought the best of the two. They were also told to draw a line through any pair of words in which one or both words were unfamiliar to them, so that the examiner might know if they actually spent time on the words or merely skipped over them. The average number of traits checked was 26.26 out of a possible 30. Eighty of the 110 completed the entire list. The average time taken, then, to make each decision was 1.71 seconds. Another criticism of this test, based on the fact that such a high percentage of the children completed it in the time interval is that the test is either too short or the time should be shortened. As it is, we have no means of determining if the children complete the test just as the "stop" signal is given, or if they have completed it sometime before. In such a case, their true rate of decision may not be determined, due to the inadequacy of the test material.

The traits were then analyzed according to a standard of what the child would be apt to be taught to believe socially undesirable. This standard, made from an average of judgments given by 5 graduate students in psychology, is as follows: Careless, daring, unambitious, selfish, tardy, bad-tempered,

inaccurate, lazy, vain, changeable, indifferent, yielding, distrustful, cowardly, stupid, bad memory, self-distrustful, hasty, unobservant, unsociable, disorderly, gloomy, impatient, slow in thought, slow in movement, holds a grudge, fond of a fight, extravagant, proud, and stingy. Of the 2889 responses given to these pairs of traits, only 259 or on an average of 2.35 per student, were undesirable, according to this standard. The two traits of an undesirable nature most frequently marked were "daring" and "proud." These are ones which we would expect young boys to consider desirable, regardless of their past training in connection with the matter. The ones, on the other hand, which undoubtedly characterized them in many instances, namely, selfish, lazy, stupid, slow in thought, etc., received the smallest number of responses. These results thus help to corroborate the criticism that the children are marking the traits which they have been taught to believe socially desirable rather than the ones which actually characterize them.

Introspection, even for adults with a certain amount of psychological training, is difficult, and we cannot for that reason expect the child to analyze these traits and know which best describes him. The best judgment which he would have of them is the one based on what his parents or teachers had told him, rather than based on his own personal opinion.

E. Motor Impulsion, X, is subject to the same criticisms as the tests for speed of movement and freedom of load. This test is based upon the amount of change which takes place when writing is carried on during certain distracting conditions, as writing with the eyes closed, counting out loud the number of taps made by the examiner, and counting to himself the number of times the examiner says "fly" in a series of words. All of these must be done while the child is writing, and his score depends upon the amount of change occurring in the writing, and the diminution in quantity. The first difficulty was in getting the actual standard from which to judge the changes. The second arose in connection with the child. His handwriting in most cases is not automatic enough to permit him to do two things at once, with the result that many of the children

paid attention to the examiner and neglected the writing, while the others concentrated on the writing and ignored what the examiner was saying or doing.

F. Self-Confidence, XI. This trait was measured by the number of statements underlined in the Memory Test. It proved to be a fairly good test, as with only a few exceptions, every child underlined at least one of the statements indicating that he understood what was desired. Contrary to the general expectation, the children did not test so high on this test as one might expect. They made only an average score of 6.84 out of a possible 16. It seems, however, to test the trait sought, and if norms were established for children, it would doubtless prove to be a very good test for them.

G. Non-compliance, XII, was scored on the number of changes made in the Memory Test after the examiner suggests that 8 of the statements are false and 8 true. (This suggestion is untrue, as all of the statements are true.) This test proved to be a rather poor one for children, because, due to the influence of prestige, resulting from the attitude of always accepting without question what a teacher or school authority says, some of the children showed a decided tendency to make changes necessary to comply with this statement. The exact following of the instructions as to how to make the changes, seemed to cause some confusion as was evidenced by the fact that in some cases both True and False were doubly underlined, or each had a circle drawn around it, which was the sign used to indicate that a change had been made. Others, on the other hand, had more than 8 marked true to begin with, and then changed the scoring so that only a few remained. It thus seemed that they were testing out the veracity of the statements rather than complying with the suggestion.

H. Finality of Judgment, XIII, was measured by the number of seconds taken to re-check the traits marked in Test 1. This proved to be a very good test for children and seemed to offer no difficulties in understanding on the part of the children, or in scoring on the part of the examiner.

I. Motor Inhibition, VII. This trait was measured by the

number of scrolls traced by the subject in a given period of time. The fewer marked, the higher the subject ranks in the ability to inhibit his motor powers. Three trials are given, but only the third is counted in the final score. The first and second parts contained 66 units of scroll with a time limit of thirty seconds and one minute, thirty seconds respectively. The third had 99 units of scroll and a time limit of two minutes, thirty seconds. For children, this test proved to be very poor because the material given was not enough to permit the ability to be completely tested. So many of the children completed the scrolls that it at once brought up the question of whether they had not perhaps finished it at some time or other before the "stop" signal was given, and thus their ability was not completely tested. Twenty-two per cent of the children completed the scrolls on the first attempt, 38 per cent on the second, and 43 per cent on the third. In addition to this criticism another, relating to the factor of interest, might be added. The children showed obvious signs of boredom by the time that the third trial was given, and this factor doubtless militated against the success and the final mark.

J. Interest in Detail, IX, was measured by copying two difficult bits of handwriting. This test proved to be extremely interesting to the children and they seemed to try hard to do their best on it, but the outcome, in a large majority of the cases, was very unsuccessful. The writing habits of the child, as we have stressed so many times before, are not firmly enough fixed to permit accurate copying of such difficult writing. In many instances, the writing was little changed from the subjects own handwriting, while in other cases, the writing was definitely changed but did not resemble the model. The first letter or so of each attempt quite often bore a close resemblance to the original, but after that, there was a decided tendency for the child to lapse into his own style.

K. Coördination of Impulses, V, was indicated by the number of letters of the phrase, "The United States of America," that the subject could write rapidly on a line $1\frac{1}{4}$ inches long in seven seconds. This on the whole brought about poor results.

Some few of the children were able to restrain their writing enough to permit the placing of all of the letters on the line. Others, however, had great difficulty and seemed to concentrate their efforts on writing as quickly as possible rather than trying to keep the letters on the line. The average number of letters kept within the given space was 14.03, which, according to the standards given by Dr. Downey, would place it in the third percentile ranking.

L. Volitional Perseveration, VIII, was measured by the time that the subject gives to the practice of disguising his handwriting. This proved to be a very good test for children and they seemed to thoroughly enjoy trying to develop a new style in writing which no one would recognize as theirs. There was a fairly wide distribution of scores with an average of 2.99 minutes spent in this practice.

These comments, on the test in general and on each test in particular, point out some of the good and bad features of the Downey Group Will-Temperament Test as a test for children in the highest grades of the elementary school. It would seem to be a test better suited for subjects of a more sophisticated type, as high school or college students. They would understand better what they are meant to do in each case, and would also have the motor facility for doing this. If the group test is to be given to children at all, it seems that it would be better to give it individually, so that the examiner could explain the instructions more thoroughly to the individual children, and so that the time might be checked up more accurately. Any slight discrepancy in starting or stopping time would so invalidate the results as to give a false picture of the trait measured. In this test, more than in Intelligence Tests where the time allotted to each part of the test is much longer, and runs up into the minutes, rather than being limited sometimes even to a fraction of a minute, it is absolutely essential that all signals be obeyed to the dot. This is difficult with adults, but is almost impossible with children unless the examiner is assisted by a large corps of monitors.

ON THE IDENTIFICATION OF CERTAIN SPOKEN WORDS BY THEIR TACTUAL QUALITIES

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In other publications[3] I have described the method of my experiments on Tactual Interpretation of Speech, etc., the nature of the stimuli that have been employed in drill and I have set forth some data relating to the course of learning in this relation. It has been demonstrated beyond doubt that the sounds of speech may be communicated as vibrations by a suitable instrument to the fingers of a totally deaf subject so that he can feel them and learn to know their meanings as we learn the significance of auditory stimuli.

Our subjects have had a great amount of drill upon the tactual correlates of each one of a given list of words and upon certain vowel and diphthongal qualities and vowel-consonant combinations.

Is there any profit in it all that can be shown in the subjects' ability to understand new words by their tactual qualities alone? By "new words" I mean combinations that *as words* had never been felt before but the vowel and other elements of which had many times been upon their fingers.

The responsibility for an answer must be put upon the laboratory. Accordingly on November 30, 1925 we wrote the

[1] On leave with the National Research Council.

[2] I am indebted to President Hall of Gallaudet College for his co-operation in the work I have in hand and to my assistants, Mr. George Crane, Miss Masne Lawntsen and Mrs. Helen Austen for their help in many ways.

[3] Jour. Abn. Psy. and Soc. Psy., XIX, No. 2, 1924; Sci. Mo., XXII, Feb., 1926; Jour. Wash. Acad. Sci., XV, No. 14, 1925; Archives of Oto-Laryngology, Feb., 1926.

names of the days of the week upon the blackboard in the presence of our deaf cases. They had never felt one of these words before that day. With the help of the subjects we marked each word to indicate where there are elements and combinations (*er*, for example, as in Saturday) that they had felt already many times. This done, with no other preparation, the experimenter went out of sight into another room, and pronounced the words into the system. Each subject in the reaction room felt his receiver[4] vibrate in unison with every spoken word. There were twenty presentations in a series but they were not in the same order in any two series. The order in the first series was as follows: Wednesday, Saturday, Sunday, Monday, Friday, Monday, Tuesday, Saturday, Thursday, Tuesday, Sunday, Tuesday, Thursday, Sunday, Wednesday, Tuesday, Monday, Saturday, Friday, Saturday.

At the end of each series we checked up the written reports. In the vertical columns below are the names that were identified by each one in turn. The figures at the right of the subjects' names indicate the number of identifications he made out of a possible twenty.

[4] "I am indebted to the Bell Telephone Laboratories for the instruments I am using in these experiments."—R. H. G.

IDENTIFICATIONS

I CLARK, 11	II AUSTIN, 10	III AUSTIN, 11	IV AUSTIN, 8	V AUSTIN, 13	VI BRAUNAGEL, 7	VII BRAUNAGEL, 16
Tues.	Sat.	Tues.	Mon.	Fri.	Tues.	Tues.
Sat.	Fri.	Sat.	Wed.	Sat.	Sat.	Thurs.
Sat.	Mon.	Fri.	Sat.	Sun.	Wed.	Sat.
Thurs.	Sat.	Sun.	Fri.	Mon.	Mon.	Wed.
Fri.	Thurs.	Thurs.	Mon.	Wed.	Sat.	Mon.
Sun.	Tues.	Sun.	Sat.	Tues.	Sat.	Fri.
Tues.	Wed.	Sat.	Sat.	Thurs.	Mon.	Sat.
Thurs.	Sat.	Fri.	Sat.	Sat.		Tues.
Sat.	Fri.	Sat.		Mon.		Sat.
Fri.	Sat.	Mon.		Sat.		Fri.
Sat.		Tues.		Wed.		Sat.
				Sat.		Tues.
				Thurs.		Wed.
						Thurs.
						Tues.
						Sun.

VIII BRAUNAGEL, 13	IX MARSDEN, 5	X MARSDEN, 6	XI MARSDEN, 12	XII NELSON, 14	XIII NELSON, 16	XIV NELSON, 19
Fri.	Sun.	Sat.	Fri.	Tues.	Tues.	Fri.
Tues.	Tues.	Tues.	Sat.	Sat.	Sat.	Fri.
Sat.	Sat.	Sat.	Mon.	Wed.	Wed.	Tues.
Sun.	Sat.	Tues.	Mon.	Mon.	Mon.	Sat.
Mon.	Tues.	Sat.	Wed.	Fri.	Fri.	Sun.
Wed.		Tues.	Tues.	Sun.	Sat.	Mon.
Tues.			Sat.	Sat.	Tues.	Mon.
Thurs.			Mon.	Wed.	Sat.	Wed.
Sat.			Fri.	Tues.	Fri.	Tues.
Tues.			Sat.	Sun.	Sat.	Thurs.
Fri.			Wed.	Sat.	Mon.	Sat.
Sat.			Sat.	Sat.	Tues.	Tues.
Sat.				Mon.	Wed.	Mon.
				Tues.	Thurs.	Fri.
					Tues.	Sat.
					Sun.	Wed.
						Sun.
						Sat.
						Thurs.
						Tues.

Following are the substitutions that were made in each of the series. In each case the sum of the substitutions and the identifications on preceding pages equals twenty.

I. CLARK, 9	II. AUSTIN, 10	III. AUSTIN, 9
Mon. for Sun.	Sun. for Tues.	Mon. for Thurs.
Thurs. for Mon.	Mon. for Sun.	Thurs. for Wed.
Wed. for Mon.	Wed. for Mon.	Wed. for Mon.
Thurs. for Wed.	Tues. for Wed.	Sun. for Mon.
Mon. for Tues.	Sun. for Tues.	Tues. for Sun.
Mon. for Sun.	Mon. for Sun.	Wed. for Sat.
Thurs. for Wed.	Sun. for Thurs.	Thurs. for Tues.
Wed. for Tues.	Mon. for Sun.	Tues. for Wed.
Sun. for Mon.	Fri. for Tues.	Mon. for Tues.
	Sun. for Mon.	

IV. AUSTIN, 12	V. AUSTIN, 7	VI. BRAUNAGEL, 13
Thurs. for Tues.	Mon. for Tues.	Fri. for Thurs.
Tues. for Thurs.	Sun. for Mon.	Thurs. for Fri.
Sun. for Tues.	Sun. for Tues.	Sun. for Mon.
Thurs. for Sun.	Thurs. for Fri.	Fri. for Sun.
Thurs. for Fri.	Tues. for Sun.	Mon. for Tues.
Wed. for Mon.	Wed. for Sun.	Tues. for Wed.
Fri. for Tues.	Fri. for Tues.	Thurs. for Sun.
Thurs. for Wed.		Sun. for Thurs.
Mon. for Sun.		Fri. for Tues.
Mon. for Tues.		Thurs. for Sun.
Tues. for Thurs.		Sun. for Fri.
Fri. for Sun.		Wed. for Sat.
		Sun. for Tues.

VII. BRAUNAGEL, 4	VII. BRAUNAGEL, 7	IX. MARSDEN, 15
Sun. for Mon.	Thurs. for Mon.	Mon. for Tues.
Mon. for Sun.	Sun. for Mon.	Tues. for Thurs.
Sun. for Mon.	Sun. for Wed.	Wed. for Sat.
Mon. for Sun.	Mon. for Sun.	Tues. for Wed.
	Fri. for Thurs.	Sat. for Mon.
	Mon. for Sun.	Mon. for Fri.
	Sun. for Tues.	Fri. for Mon.
		Wed. for Sat.
		Thurs. for Tues.
		Sun. for Wed.
		Thurs. for Sun.
		Mon. for Thurs.
		Fri. for Sun.
		Mon. for Fri.
		Sun. for Mon.

X. MARSDEN, 14	XI. MARSDEN, 8	XII. NELSON, 6
Sun. for Mon.	Sun. for Tues.	Thurs. for Fri.
Tues. for Wed.	Mon. for Sun.	Mon. for Sun.
Mon. for Tues.	Sun. for Thurs.	Thurs. for Tues.
Mon. for Thurs.	Thurs. for Mon.	Mon. for Sun.
Mon. for Fri.	Thurs. for Sun.	Tues. for Thurs.
Sun. for Mon.	Tues. for Thurs.	Thurs. for Fri.
Wed. for Sun.	Mon. for Sun.	
Tues. for Fri.	Fri. for Tues.	
Thurs. for Mon.		
Wed. for Sat.		
Sun. for Wed.		
Mon. for Sun.		
Fri. for Thurs.		
Thurs. for Sun.		

XIII. NELSON, 4	XIV. NELSON, 1
Fri. for Thurs.	Mon. for Sun.
Sun. for Mon.	
Thurs. for Sun.	
Mon. for Sun.	

SUBSTITUTIONS AND THEIR FREQUENCIES

SUNDAY (GIVEN 42 TIMES)	*times*	MONDAY (GIVEN 42 TIMES)	*times*
Reported as Monday	17	Reported as Sunday	12
Reported as Tuesday	2	Reported as Tuesday	0
Reported as Wednesday	2	Reported as Wednesday	4
Reported as Thursday	7	Reported as Thursday	3
Reported as Friday	3	Reported as Friday	2
Reported as Saturday	0	Reported as Saturday	1
Total	31	Total	22

TUESDAY (GIVEN 56 TIMES)		WEDNESDAY (GIVEN 28 TIMES)	
Reported as Sunday	7	Reported as Sunday	3
Reported as Monday	7	Reported as Monday	0
Reported as Wednesday	1	Reported as Tuesday	5
Reported as Thursday	3	Reported as Thursday	4
Reported as Friday	5	Reported as Friday	0
Reported as Saturday	0	Reported as Saturday	0
Total	23	Total	12

THURSDAY (GIVEN 26 TIMES)		FRIDAY (GIVEN 28 TIMES)	
Reported as Sunday	3	Reported as Sunday	1
Reported as Monday	1	Reported as Monday	3
Reported as Tuesday	5	Reported as Tuesday	1
Reported as Wednesday	0	Reported as Wednesday	0
Reported as Friday	4	Reported as Thursday	4
Reported as Saturday	0	Reported as Saturday	0
Total	13	Total	9

SATURDAY (GIVEN 52 TIMES)

	times
Reported as Sunday	0
Reported as Monday	0
Reported as Tuesday	0
Reported as Wednesday	5
Reported as Thursday	0
Reported as Friday	0
Total	5

	IDENTIFIED	POSSIBLE	CHANCE
Clark	11	20	$2\frac{6}{7}$– 3
Austin	42	80	$11\frac{3}{7}$–12
Braunagel	36	60	$8\frac{4}{7}$– 9
Marsden	23	60	$8\frac{4}{7}$– 9
Nelson	49	60	$8\frac{4}{7}$– 9
Totals	161	280	40 –42

Aggregate of identifications possible for whole group..... 280
Actual number of identifications by whole group..... 161
Aggregate of identifications possible for whole group by chance... 40–42

ORDER OF LIABILITY TO MISINTERPRETATION

Saturday	0.096
Friday	0.32
Tuesday	0.41
Wednesday	0.428
Thursday	0.5
Monday	0.523
Sunday	0.737

SUBSTITUTIONS IN ORDER OF FREQUENCIES

For Sunday:

Monday	15
Thursday	7
Friday	3
Tuesday	2
Wednesday	2

For Monday:

Sunday	11
Wednesday	4
Thursday	4
Friday	1
Saturday	1

For Tuesday:

Monday	7
Sunday	7
Friday	5
Thursday	4
Wednesday	1

For Wednesday:

Tuesday	5
Thursday	4
Sunday	3

For Thursday:

Tuesday	5
Friday	4
Sunday	3
Monday	3

For Friday:

Thursday	5
Monday	3
Sunday	1
Tuesday	1

For Saturday:

Wednesday	5

IDENTIFICATION OF THE NAMES OF THE MONTHS

On November 25, December 1 and 2 we made precisely this test employing the names of the months as stimuli. The preparation for the exercise was exactly what I have described in relation to the names of the days of the week and no more. The words "June" and "May" (the latter as an auxiliary verb) had already occurred many times in drill. The other words were all total strangers. The subject "Hughes" had had no experience in our laboratory prior to December first.

The analysis follows:

I CLARK, 6	II CLARK, 8	III AUSTIN, 13	IV AUSTIN, 16	V AUSTIN, 12
Mar.	Mar.	Mar.	Oct.	Apr.
Nov.	May	Jan.	June	July
Apr.	Jan.	June	Sept.	Oct.
July	Aug.	Oct.	July	Dec.
Aug.	Sept.	Dec.	Jan.	Mar.
Nov.	Feb.	Oct.	Apr.	Aug.
	Mar.	July	Nov.	Aug.
	Nov.	May	Feb.	Feb.
		Aug.	Mar.	Nov.
		Dec.	Oct.	Apr.
		Feb.	July	Mar.
		Jan.	May	Oct.
		July	Aug.	
			Dec.	
			July	
			Feb.	

VI AUSTIN, 13	VII AUSTIN, 15	VIII BRAUNAGEL, 4	IX BRAUNAGEL, 10	X MARSDEN, 9
Oct.	Mar.	June	Mar.	Oct.
Aug.	May	July	May	Apr.
Dec.	Apr.	Feb.	Sept.	Nov.
Mar.	Jan.	Mar.	Mar.	Oct.
Jan.	Oct.		Oct.	May
Apr.	Dec.		April	Aug.
July	Aug.		Aug.	Nov.
May	June		Feb.	Jan.
Mar.	Feb.		Jan.	Feb.
Oct.	May		July	
Aug.	Mar.			
Nov.	Aug.			
May	July			
	Oct.			
	April			

XI MARSDEN, 14	XII MARSDEN, 9	XIII NELSON, 16	XIV NELSON, 17	XV HUGHES, 3
Apr.	Oct.	Dec.	Oct.	Oct.
Oct.	Aug.	Oct.	Aug.	Aug.
Dec.	Dec.	Sept.	Mar.	July
Mar.	Mar.	July	Jan.	
Jan.	Apr.	Jan.	Apr.	
Aug.	May	Apr.	July	
Aug.	Aug.	Nov.	May	
Feb.	Nov.	Feb.	June	
Nov.	May	Mar.	Mar.	
Apr.		July	Oct.	
Mar.		May	Apr.	
July		Aug.	Aug.	
Oct.		Sept.	Feb.	
June		July	Jan.	
		Jan.	Nov.	
		Feb.	May	
			July	

Substitutions

I. CLARK, 14	II. CLARK, 12	III. AUSTIN, 7
June for Feb.	July for Apr.	Jan. for Feb.
Aug. for Jan.	Dec. for Oct.	Dec. for Nov.
Dec. for Sept.	Nov. for Dec.	Feb. for Apr.
July for June	June for July	Mar. for July
Sept. for Oct.	May for June	Feb. for Sept.
Nov. for Dec.	Oct. for Jan.	Jan. for Nov.
Dec. for Oct.	Dec. for Nov.	Nov. for Sept.
June for July	June for May	
April for May	Jan. for Aug.	
Sept. for Dec.	*Blank* for July	
Jan. for Feb.	Sept. for Oct.	
July for Jan.	Jan. for Apr.	
Mar. for July		
Feb. for Sept.		

IV. AUSTIN, 4	V. AUSTIN, 8	VI. AUSTIN, 7
Feb. for Dec.	Nov. for Dec.	Mar. for June
Jan. for Sept.	June for May	Dec. for Sept.
Oct. for Nov.	Feb. for Jan.	Feb. for Apr.
Nov. for Jan.	May for June	Jan. for Feb.
	Sept. for Jan.	Feb. for Jan.
	Dec. for Sept.	Apr. for Nov.
	June for July	Sept. for July
	May for June	

VII. AUSTIN, 5	VIII. BRAUNAGEL, 16	IX. BRAUNAGEL, 10
June for July	Nov. for Dec.	Feb. for Oct.
Dec. for Sept.	Apr. for Oct.	Apr. for Aug.
Nov. for Jan.	Jan. for Sept.	Jan. for Dec.
Jan. for Nov.	Sept. for Jan.	July for Jan.
Jan. for Nov.	Aug. for Apr.	Aug. for Apr.
	Dec. for Nov.	June for July
	Dec. for Oct.	Aug. for June
	Aug. for July	Dec. for Nov.
	July for May	Oct. for Nov.
	Apr. for Aug.	June for May
	Nov. for Dec.	
	Oct. for Sept.	
	Sept. for Nov.	
	June for July	
	Apr. for Jan.	
	Jan. for Feb.	

X. MARSDEN, 11	XI. MARSDEN, 6	XII. MARSDEN, 11
Sept. for Dec.	May for July	Feb. for Jan.
Jan. for June	Sept. for Dec.	June for July
Dec. for Sept.	June for May	Mar. for June
Mar. for July	July for June	Oct. for Sept.
July for Jan.	Dec. for Jan.	Nov. for Mar.
Jan. for Feb.	Oct. for Sept.	Dec. for Oct.
June for Mar.		July for Apr.
June for July		Jan. for Feb.
Sept. for Dec.		Feb. for Jan.
Nov. for Sept.		Sept. for Nov.
Feb. for July		Mar. for July

XIII. NELSON, 4	XIV. NELSON, 3	XV. HUGHES, 17
Mar. for June	Sept. for Dec.	May for Mar.
Sept. for Oct.	Nov. for Sept.	June for May
Nov. for Dec.	Sept. for Nov.	Aug. for Apr.
Oct. for Nov.		Sept. for Jan.
		Apr. for Dec.
		Jan. for Aug.
		Dec. for July
		June for Sept.
		Feb. for June
		Jan. for Feb.
		July for Jan.
		Sept. for Nov.
		June for May
		Apr. for Mar.
		Oct. for Nov.
		Feb. for Oct.
		Aug. for Apr.

Substitutions and their frequencies

JANUARY (GIVEN 30 TIMES)	*times*	FEBRUARY (GIVEN 21 TIMES)	*times*
Reported as Feb	4	Reported as Jan	7
Reported as Mar	0	Reported as Mar	0
Reported as Apr	1	Reported as Apr	0
Reported as May	0	Reported as May	0
Reported as June	0	Reported as June	1
Reported as July	4	Reported as July	0
Reported as Aug	1	Reported as Aug	0
Reported as Sept	3	Reported as Sept	0
Reported as Oct	1	Reported as Oct	0
Reported as Nov	2	Reported as Nov	0
Reported as Dec	1	Reported as Dec	0
Total	17	Total	8

MARCH (GIVEN 24 TIMES)		APRIL (GIVEN 24 TIMES)	
Reported as Jan	0	Reported as Jan	1
Reported as Feb	0	Reported as Feb	2
Reported as Apr	1	Reported as Mar	0
Reported as May	1	Reported as May	0
Reported as June	1	Reported as June	0
Reported as July	0	Reported as July	2
Reported as Aug	0	Reported as Aug	4
Reported as Sept	0	Reported as Sept	0
Reported as Oct	0	Reported as Oct	0
Reported as Nov	1	Reported as Nov	0
Reported as Dec	0	Reported as Dec	0
Total	4	Total	9

MAY (GIVEN 23 TIMES)		JUNE (GIVEN 16 TIMES)	
Reported as Jan	0	Reported as Jan	1
Reported as Feb	0	Reported as Feb	1
Reported as Mar	0	Reported as Mar	4
Reported as Apr	1	Reported as Apr	0
Reported as June	6	Reported as May	3
Reported as July	1	Reported July	2
Reported as Aug	0	Reported as Aug	1
Reported as Sept	0	Reported as Sept	0
Reported as Oct	0	Reported as Oct	0
Reported as Nov	0	Reported as Nov	0
Reported as Dec	0	Reported as Dec	0
Total	8	Total	12

JULY (GIVEN 36 TIMES)		AUGUST (GIVEN 24 TIMES)	
	times		*times*
Reported as Jan	0	Reported as Jan	2
Reported as Feb	1	Reported as Feb	0
Reported as Mar	4	Reported as Mar	0
Reported as Apr	0	Reported as Apr	2
Reported as May	1	Reported as May	0
Reported as June	8	Reported as June	0
Reported as Aug	1	Reported as July	0
Reported as Sept	1	Reported as Sept	0
Reported as Oct	0	Reported as Oct	0
Reported as Nov	0	Reported as Nov	0
Reported as Dec	1	Reported as Dec	0
Total	17	Total	4

SEPTEMBER (GIVEN 21 TIMES)		OCTOBER (GIVEN 30 TIMES)	
Reported as Jan	2	Reported as Jan	0
Reported as Feb	2	Reported as Feb	2
Reported as Mar	0	Reported as Mar	0
Reported as Apr	0	Reported as Apr	1
Reported as May	0	Reported as May	0
Reported as June	1	Reported as June	0
Reported as July	0	Reported as July	0
Reported as Aug	0	Reported as Aug	0
Reported as Oct	3	Reported as Sept	1
Reported as Nov	3	Reported as Nov	0
Reported as Dec	5	Reported as Dec	4
Total	16	Total	8

NOVEMBER (GIVEN 28 TIMES)		OCTOBER (GIVEN 30 TIMES)	
Reported as Jan	3	Reported as Jan	1
Reported as Feb	0	Reported as Feb	1
Reported as Mar	0	Reported as Mar	0
Reported as Apr	1	Reported as Apr	1
Reported as May	0	Reported as May	0
Reported as June	0	Reported as June	0
Reported as July	0	Reported as July	0
Reported as Aug	0	Reported as Aug	0
Reported as Sept	4	Reported as Sept	5
Reported as Oct	4	Reported as Oct	0
Reported as Dec	4	Reported as Nov	6
Total	16	Total	14

FOR JANUARY		FOR FEBRUARY		FOR MARCH		FOR APRIL	
Feb.	4	Jan.	7	Apr.	1	Aug.	4
July	4	June	1	May	1	July	2
Sept	3			June	1	Feb.	2
Nov.	2			Nov.	1	Jan.	1
Apr.	1						
Aug.	1						
Oct.	1						
Dec.	1						

FOR MAY		FOR JUNE		FOR JULY		FOR AUGUST	
June	6	Mar.	4	June	8	Jan.	2
Apr.	1	May	3	Mar.	4	Apr.	2
July	1	July	2	Feb.	1		
		Jan.	1	May	1		
		Feb.	1	Aug.	1		
		Aug.	1	Sept.	1		
				Dec.	1		

FOR SEPTEMBER		FOR OCTOBER		FOR NOVEMBER		FOR DECEMBER	
Dec.	5	Dec.	4	Sept.	4	Nov.	6
Nov.	3	Feb.	2	Oct.	4	Sept.	5
Oct	3	Apr.	1	Dec.	4	Jan.	1
Jan.	2	Sept.	1	Jan.	3	Feb.	1
Feb.	2			Apr.	1	Apr.	1
June	1						

	IDENTIFIED	POSSIBLE	CHANCE
Clark	14	40	3½
Austin	69	100	8½
Braunagel	14	40	3½
Marsden	32	60	5
Nelson	33	40	3½
Hughes	3	20	1⅔
Totals	165	300	25–27

Aggregate of identifications possible for whole group..... 300
Actual number of identifications by whole group..... 165
Aggregate of possible correct guesses by whole group..... 25–27

Order of liability to misinterpretation

March	0.166	July	0.472
August	0.166	January	0.566
October	0.266	November	0.57
May	0.347	December	0.6
April	0.37	June	0.75
February	0.38	September	0.76

Similar experiments have been made in which the names of fruits, animals, birds, cities, states, nations and the like have been employed as stimuli; twenty tests in all. The results are of the same character as the foregoing.

MORAL JUDGMENT IN FEMALE DELINQUENTS

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The current neglect of the question of the influence of moral ideas on delinquency is excusable in view of the difficulty of devising tests of moral judgment. The Brogan Test of Moral Perception offers so much interesting data regarding the moral ideas of normals that the writer took advantage of an opportunity of giving it to a group of 138 female delinquents at the Geneva Reformatory in Nebraska. The major findings of this study point emphatically to certain significant conclusions.

The Brogan "list," it will be recalled,[1] consists of a list of 16 "bad" practices, which were suggested by university students. In employing this list as a test, the subject is required to put them in the order of "badness." This is accomplished by placing the number *one* after the worst practice, and so on. The objection has been made that some subjects might regard certain practices in this list as not "bad" at all. But this circumstance hardly prevents them from arranging them in the order of their *badness*. Even indifferent or good practices differ in the degree of their indifference or goodness. Of course, directions to the subjects should make this matter clear to them. However, the writer conformed closely to the practice of Mr. Brogan in giving this test for the sake of securing comparative results. The subjects were warned to give their own judgments, not what they were supposed to say. Their names were not taken at all. It was explained to them that their identity was effectually concealed in these tests. Unfortu-

[1] A. P. Brogan. Moral valuations about men and women. International Journal of Ethics, Vol. 35, 105–124.

TABLE 1

PRACTICES	ORDER OF BADNESS		AVERAGE DEVIATION	
	University women	Reformatory women	University women	Reformatory women
Sex irregularity	1	1	1.96	2.54
Stealing	2	3	2.18	2.23
Cheating	3	9	2.18	3.46
Lying	4	3	2.48	2.66
Drinking	5	4	2.95	2.58
Gambling	6	8	2.44	2.44
Vulgar talk	7	6	2.64	2.42
Sabbath breaking	8	5	3.42	3.65
Swearing	9	7	2.23	2.60
Gossip	10	11	2.97	2.78
Selfishness	11	14	3.14	2.20
Idleness	12	13	3.06	2.74
Snobbishness	13	15	2.38	1.97
Extravagance	14	13	2.38	2.88
Smoking	15	10	1.96	2.73
Dancing	16	16	1.87	2.79
Average deviation			2.52	2.67

As to order of badness, there is remarkable agreement between the two groups. The reformatory women represent drinking, extravagance, lying, Sabbath breaking, smoking, swearing, and vulgar talk as more serious offenses than do the college women. On the other hand, the college women consider cheating, gambling, gossip, idleness, selfishness, snobbishness, and stealing as more serious offenses than do the reformatory cases. Differences are pronounced only as regards cheating. We naturally expect the reformatory women to rank this as a less than average offense, because they are not by training familiar with its evils. Sabbath breaking offers another rather marked difference, but the Brogan list as used among college students shows that this is typically the point of greatest diversity of judgment. On the whole, the reformatory women do seem to show more the influence of traditional Christian morality, which the college women escape, presumably because of the so-called "liberalizing" influence of university life. This does not imply, of course, that this liberalizing influence is not in the right direction. Another result of importance is the fact that the reformatory cases hardly deviate any more from their group averages than do the university women.

nately, the request to show the relation of the offenses of these subjects to their moral evaluations was refused by the officials of the institution. However, the cases are almost entirely sex offenders of the "unfortunate mother" type.

The Brogan list is significant because it has been given to thousands of university students, representing good samplings from the United States as a whole; and also because the test has yielded almost the same results, irrespective of place or sex. Table 1 gives a comparison of the reformatory cases and university women, both as regards order of "badness," and deviation from the group average.

GENERAL CONCLUSIONS

1. The delinquency of these cases is not due to the absence of normal moral insight. In this, they are approximately the equals of university women.

2. We must then look for the causes of their deficiency in the emotional, volitional, or intellectual sphere.

3. These cases again show the normality of their moral judgment by the absence of "rationalization." That is, in spite of the fact that most of these 138 cases are sex offenders, they designate sex offenses as the most serious.

These conclusions are of course highly tentative. If other more sweeping and adequate studies should confirm these results, it would indicate that moral instruction (*a*) either fails to seriously affect the conduct of man, or else (*b*) that at least the moral instruction of the past has failed to do so.

THE RETURNS FROM FOLLOW-UP LETTERS TO QUESTIONNAIRES

HERBERT A. TOOPS

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The writer has previously pointed out the desirability and possibility of securing practically perfect returns to a questionnaire.[1] In this previous report 93 per cent of returns from 96 former trade school students were secured by the use of

TABLE 1

Cumulative percentage of returns received, by number of follow-up letters sent, in two investigations

NUMBER OF FOLLOW-UP LETTERS SENT	CUMULATIVE PER CENT OF REPLIES RECEIVED	
	Students (former study)	College people (this study)
Initial questionnaire	8	53
1	26	65
2	56	83
3	69	88
4	76	97
5	93	99
6		100
Number of questionnaires received by recipients.....	96	110

five follow-up letters. The writer recently has secured by the use of six follow-up letters 100 per cent of returns from 110 questionnaires, on the use of university intelligence tests,[2] sent

[1] Toops, H. A. Validating the Questionnaire Method. Journal of Personnel Research, vol. 2, nos. 4 and 5, August–September, 1923, pp. 153–169.

[2] To appear shortly.

to college professors and administrative authorities. The cumulative returns from the questionnaires of the two investigations are given in table 1. The follow-up letters used in the second investigation are given in the appendix to this article.

In an effort to determine what factors in the second investigation might underly slow answering, several tables were prepared,

TABLE 2

Relationship between willingness to have answers published and possession of a reliability coefficient for tests used

RELIABILITY OF TESTS	WISH ANSWERS KEPT CONFIDENTIAL	DO NOT DESIRE TO HAVE ANSWERS KEPT CONFIDENTIAL	TOTAL
Know reliability of tests used	5	15	20
Do not know reliability of tests used	7	52	59
Total	12	67	79

TABLE 3

Relationship between willingness to have answers published and possession of a validity coefficient for tests used

VALIDITY OF TESTS	WISH ANSWERS KEPT CONFIDENTIAL	DO NOT DESIRE TO HAVE ANSWERS KEPT CONFIDENTIAL	TOTAL
Validity of 0.47 or above*	2	20	22
Validity of 0.46 or below	4	20	24
Do not know validity	6	27	33
Total	12	67	79

* The median validity coefficient was 0.46.

a few of which are given below. The twenty-sixth question of the questionnaire was: "Do you wish your answers to be kept confidential?" The relationship of the answers on this question to possession of a reliability coefficient for the test used is given by table 2. An inspection of this table indicates a very slight association between knowing the reliability of their tests and wishing to keep their answers confidential.

TABLE 4

Relationship between use or non-use of tests, their validity, and number of follow-up letters required to secure a reply

(Experimental use is counted as use in this table)

NUMBER OF FOLLOW-UP LETTERS REQUIRED	NUMBER OF COLLEGES WHICH					GRAND TOTAL
	Do not use tests	Use tests				
	Total	Total	Do not know validity	Validity 0.46 or less	Validity 0.47 or above	
0	15	43	16	15	12	58
1	4	10	5	3	2	14
2	6	13	5	5	3	19
3	1	5	3		2	6
4	4	6	4		2	10
5		2		1	1	2
6	1					1
Total.....	31	79	33	24	22	110

TABLE 5

Relationship of degree of friendship of sender of questionnaire for recipient of questionnaire to number of follow-up letters required to elicit a reply

NUMBER OF FOLLOW-UP LETTERS	DEGREE OF FRIENDSHIP				TOTAL
	0	1	2	3	
0	39	7	8	4	58
1	11		1	2	14
2	14	1	2	2	19
3	5	1			6
4	9		1		10
5	2				2
6	0	1			1
Total.....	80	10	12	8	110
Average number of follow-ups sent per reply received.....	1.25	1.10	0.75	0.75	1.14

The validity coefficients of the five colleges which know the reliability of their tests and wish to have the answers kept confidential are all under 0.50.

A tabulation of the relationship of willingness to have answers published and validity yields table 3. This table indicates an association between low or unknown validity coefficients and desire to have answers kept confidential.

In table 4 then, we have considered only validity and use or non-use of tests in relation to the number of follow-up letters required to secure a reply.

It is evident from this table that the possession or non-possession of a high validity coefficient is no guarantee of either early or late reply to the questionnaire. It is definitely known from several letters however that the replies were held up until the validity coefficient and reliability coefficients could be computed. This may account for a portion of the lack of relationship.

We have so far found no measure which is highly associated with the number of follow-up letters required. We might investigate the following in their bearing on the problem.

1. Size of the school
2. Endowment per student in attendance as an indirect measure of spare time of college recipient
3. Extent to which sender of questionnaire was known to recipient of questionnaire

The first two were not investigated. The third was investigated but by the method of reverse judgment, by having the sender of the questionnaire judge the extent to which he knew the recipient of the questionnaire on a four-point scale as follows:

DEGREE	DESCRIPTION OF TRAIT
0	Recipient unknown to sender
1	Recipient known slightly in a professional way to sender
2	Recipient known slightly in a social or friendship way to sender
3	Recipient known more or less intimately to sender

The results are shown in table 5.

The bottom row of table 5 indicates a somewhat greater tendency for the sender's better known friends to reply earlier than less well known recipients of the questionnaire.

The most important point to be settled is, of course, were six follow-up letters essential? Could we have used merely one follow-up only and have secured the same results. Table 6 answers one aspect of the question satisfactorily. It is evident—so far as this investigation is concerned—that substantially the same conclusion with respect to the *extent of the use of tests* could have been arrived at with no follow-up letters at all. With respect to other conclusions this would not necessarily

TABLE 6

NUMBER OF FOLLOW-UP LETTERS	CUMULATIVE NUMBER OF LETTERS SENT TO DATE	PER CENT OF COLLEGES USING TESTS	CUMULATIVE PER CENT OF 110 COLLEGES REPLYING
0	110	74.1	52.7
1	162	73.6	65.4
2	200	72.5	82.7
3	219	73.2	89.2
4	232	72.0	97.2
5	235	72.5	99.1
6	236	71.8	100.0

hold. Additional replies did increase the *list of practical suggestions for improving tests*, even if they did not change materially the conclusions with respect to the *extent of the use* of tests.

SUMMARY

1. Sheer repetition of stimuli, by follow-up letters, is apparently the most potent method of eliciting replies from all recipients of a questionnaire. There were 52.7 per cent of replies to the initial questionnaire. Six follow-up letters were required to elicit 100 per cent of replies.

2. There is a decided tendency for those recipients who are best known to the sender to reply earlier than strangers.

3. There is no significant relation between size of validity coefficient and earliness of reply.

4. Colleges with low validity coefficients were more solicitous that their answers should be kept confidential than colleges with high validity coefficients.

5. In this investigation one essential conclusion—the percentage of colleges using or not using tests—would not have been materially changed if no follow-up letters had been used.

6. Many other factors—amount of spare time of recipient, teaching load of recipient, form, and content of letters; ease of forms for answering; size of institution—have undoubtedly their effects but were not investigated.

7. Where great accuracy of any percentage is desired, we can usually secure practically perfect returns on any well-worded and easily answered questionnaire of 30 questions by the use of some half-dozen follow-up letters. What percentage of replies is needed in most questionnaires for practical fixing of essential percentages is a subject for future research which it is hoped this article may stimulate.

8. The returns for the college group were one return for every 2.1 letters; for the trade school group of a previous investigation one return for every 5.9 letters. In both cases five follow-up letters elicited over 90 per cent of replies.

APPENDIX

The original or accompanying letter, and the six follow-up letters used in the second investigation are as follows:

Original letter:

Columbus, Ohio,
March 10, 1924.

Dear Sirs:

We have recently completed a survey of the official uses of intelligence tests in the colleges and universities of Ohio. We find a widespread use of the tests even in comparatively small colleges. We now desire to extend our survey in order to study intensively the administration and use of such tests in the larger colleges and universities, with a view to improvement of present techniques. It is expected that the results will be published.

We are fairly well acquainted with the available literature, but in

many cases the practices which obtained at the time of such publications are now obsolete; and at best, conclusions derived from publications not specifically written with the point of view of answering the questions which need to be answered, should be officially verified before being treated as scientific data.

May we have your answers at your earliest convenience?

Very sincerely yours,

P.S. We are enclosing a copy of our experimental individual guidance card. The student encircles his scores on the various test variables and immediately notes his decile standing in each test whose norms (college freshmen) appear on the face of the card. On the rear, we plot cumulative credit points gained (A marks = 4; B marks = 3, etc.) against cumulative number of hours taken, and thus will detect *at an early date* those students who, although doing "passing work," are, nevertheless, as to quality of school marks in the (light cross-hatched) "danger-of-not-graduating" area of the card.

Original letter: 245 words; 25 question questionnaire accompanying; 58 replies received from 110 letters sent out.

1. First follow-up letter:

Columbus, Ohio,
April 9, 1924.

Dear Sirs:

Our records to date show that we have not yet received a return from you on the intelligence questionnaire sent you recently. We have not yet begun the tabulation of the replies, and accordingly there is still ample time for you to send in your reply. Please do so *even though you are not* officially using such tests. May we not have your reply at once?

Very sincerely yours,

P.S. By means of a simple one-page questionnaire, we have determined that 40 per cent of *all* Ohio Colleges use intelligence tests. The longer questionnaire sent you was designed to determine what is the best practice in a selected list of about 120 of the larger and better known Universities and Colleges of the entire country. To date 58 of these have responded. Will you not help to make our returns 100 per cent by responding to this first follow-up letter by sending in your questionnaire in order that the results of the replies may be published for the benefit of all.

First follow-up letter: 165 words; 14 replies received from 52 letters sent out.

2. Second follow-up letter:

Columbus, Ohio, April 25, 1924.

Dear Sir:

All but 38 of the 110 colleges and universities to whom we sent on March 12th, a questionnaire regarding the use of intelligence tests have replied. In a few cases the addresses were incomplete and so did not reach the person intended. Such addresses have been corrected to the best of our ability, and hence we are in doubt as to the reason for our not yet having heard from you. We have been personally "bothered" with questionnaires in the past. It was with some misgivings therefore that, after deliberation, we decided to "bother" busy college people with a questionnaire. We then reduced the work involved in replying to a minimum. You will note that practically all of the questions can be answered with either a check mark, a number, or a single word. That 72 colleges should have responded with but one follow-up letter is gratifying. If but 37 other people, in addition to yourself, respond to this letter we shall have full returns and can then be assured that we do not have a biased selection of colleges.

Perhaps you are not the person to whom the questionnaire should have been addressed; if so, will you please hand the questionnaire to a colleague who is in closer touch with such personnel work? And perhaps you have lost the former questionnaire (sometimes they go the way of the waste paper basket). At any rate, we are enclosing another for your convenience in sending us a prompt reply. Let us repeat that the tabulated results will be published for the benefit of all. May we not have the benefits of your experience with such tests?

Yours very sincerely,

Second follow-up letter: 275 words and a second copy of questionnaire: 19 replies received from 38 letters sent out.

3. Third follow-up letter:

Columbus, Ohio, May 20, 1924.

Dear Sirs:

Columbia, Yale, Brown, Newcomb College, Mount Holyoke College —91 of the 110 colleges originally sent the enclosed questionnaire on the uses of intelligence tests—have replied. Why is your college "among the missing?" We trust we shall not be required to report it "no return received" when we publish our report. If you do *not* use tests, please return the questionnaire with question No. 1, marked "No" in order that our returns may be 100 per cent complete. As a suggestion perhaps over the week-end you will have fifteen minutes in which you can answer the questions.

Very sincerely yours,

P.S. Only 19 more returns now needed to make 100 per cent. We received just 19 replies to our last letter. We did not wish to cut a stencil, but the job is a little too large for 19 typewritten letters,—so please excuse the carbon copy if you happen to receive one.

Third follow-up letter: 146 words; 6 replies received from 19 letters sent out.

4. Fourth follow-up letter:

Columbus, Ohio, June 11, 1924.

To the President (or Registrar in certain cases).

Dear Sir:

We have sent an original letter and three follow-up letters to the following address at your college in an attempt to secure replies to a questionnaire dealing with the results of the use of intelligence tests in your college:

Professor John Doe, Blank College

We have so far received no reply. To date all but 13 of 110 colleges throughout the country originally sent these questionnaires have replied. We are very anxious to have your college represented in the returns. Will you please either take 15 minutes and answer for us the questions included herewith, or hand the questionnaire to the proper person in possession of the facts called for?

Very sincerely yours,

Fourth follow-up letter: 106 words. Sent to a different official (usually president) of the colleges which had not yet replied: 10 replies received from 13 letters sent out.

5. Fifth follow-up letter:

Columbus, Ohio, July 8, 1924.

Dear Sir:

On the enclosed questionnaire on the uses of intelligence tests only your college and two other remain to be heard from. We hope to have University of X represented. Will you please request someone in your university in possession of the facts to fill out the questionnaire and return it to me? The questionnaire was sent to 110 representative colleges and universities of the United States.

Very sincerely yours,

Fifth follow-up letter: 66 words; sent to recipients of the fourth follow-up letter; two replies from three letters sent out.

6. Sixth follow-up letter:

Columbus, Ohio, August 5, 1924.

Secretary of the Entrance Board
Blank College

Dear Sirs:

I have sent the enclosed questionnaire to Professor Blank and to the President of your University and have thus far had no reply from either. Your University is the only one among 110 universities throughout the country, selected because of geographical and other representative characteristics, which has not replied to this questionnaire. We are very desirous of having complete returns on all of the colleges to which these questionnaires were sent. The general results of the questionnaire will be published. May we hope to have your reply at your earliest convenience.

Very sincerely yours,

Sixth follow-up letter: 91 words. Questionnaire enclosed. Since previous letters sent to one professor and the registrar had failed, this sixth letter was sent to the Secretary of the Entrance Board who replied immediately.

A DEMONSTRATION OF THE LANGUAGE DIFFICULTY INVOLVED IN COMPARING RACIAL GROUPS BY MEANS OF VERBAL INTELLIGENCE TESTS

S. L. WANG

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Racial differences in intelligence certainly constitute a very interesting and important subject. The wide interest in this topic has led many psychologists to attempt measurement of the differences by means of verbal intelligence tests. The findings have not been wholly consistent, but there has been fairly general agre ment that other races tested as inferior to the native white Americans. However, whether these low scores were due to inferior intelligence was still an open question. There are clearly other factors besides comparative intelligence involved in such comparisons. The most important one is the language difficulty. It is the purpose of this study to make further investigation as to whether there is a language handicap involved in comparing racial groups by means of verbal intelligence tests.

MATERIALS

The results worked with in this study were from students at the Ohio State University. The test used was the Ohio State University Intelligence Test—to be further described shortly. The cases studied were 34 Chinese students, 83 men and 75 women colored students, 45 students born in Russia, and native born white cases paired with these as taking the same form of the test, of the same percentile standing (always within 5—usually exactly the same), belonging to the same college (Arts, Education, and Commerce and Journalism students being grouped together as sufficiently similar in entering students personnel, however) and class, of the same sex, and about the same age.

METHODS AND RESULTS

The method of handling, once the cases were thus carefully selected, was simple. The results for each racial group were tabulated by test, and then on a separate table the paired American cases. The median for foreign and paired American group was then found, for each test, and the median for the

TABLE 1

Differences between foreign and colored groups and paired American groups on the separate tests of the Ohio State University Intelligence Tests

	RACIAL GROUP					
	Chinese	Male Negroes	Female Negroes	Male Negroes	Female Negroes	Russians
Forms Number of cases	3 and 4 34	3 and 4 61	3 and 4 53	5 and 6 22	5 and 6 22	5 and 6 45
Test 1*	0	1	1	0	−2.5	1
Test 2	−1.5	−1	0	−2	1.5	1
Test 3	1	−1	1	2	5.5	−3
Test 4	1	−1	−1	4	2.5	1
Test 5	−8.5	0	3	0	0	0
Test 6	−5	1	1	0	0	1
Test 7	9	0	−1	0.5	1	0
Test 8				2	1.5	0

* The table shows that on test 1, Forms 3 and 4, the medians of the paired American groups are the same as that of the Chinese and are 1 step higher than that of the Male Negroes and Female Negroes. On test 1, Forms 5 and 6, the medians of the paired American groups are same as that of the Male Negroes and are 1 step higher than that of the Russians and 2.5 steps lower than that of the Female Negroes; and so on.

foreign group subtracted from the median for the American group. These differences appear in table 1.[1]

The tests are as follows:

Forms 3 and 4	*Forms 5 and 6*
Test 1. Arithmetical problems	Test 1. Arithmetical problems
Test 2. Proverbs	Test 2. Definition
Test 3. Same and opposite	Test 3. Same and opposite

[1] In this table results are given separately for the earlier Forms 3 and 4 and the recent revision—Forms 5 and 6.

Test 4. Dissected sentences	Test 4. Synonyms
Test 5. Number series	Test 5. General academic information
Test 6. Analogies	Test 6. Number series
Test 7. General information	Test 7. Analogies
	Test 8. Reading

The following points are to be noted:

1. The Chinese are decidedly superior to the paired Americans on Test 5, Forms 3 and 4. The Americans average 8.5 steps below the Chinese. Test 5 is a test of number series and consequently involves very little language difficulty.

TABLE 2

Race differences in terms of sigma

	RACIAL GROUPS		
	Chinese	Negroes	Russians
Forms	3 and 4	5 and 6	5 and 6
Number of cases	34	44	45
Test 1	−0.13	−0.30	−0.16
Test 2	−0.93	−0.53	−0.29
Test 3	−0.64	−0.48	−0.34
Test 4	−0.85	−0.55	−0.42
Test 5	+0.31	−0.43	−0.38
Test 6	−0.33	−0.29	−0.12
Test 7	−1.89	−0.46	−0.31
Test 8		−0.59	−0.22

2. The Chinese are decidedly inferior to the paired Americans on Test 7, Forms 3 and 4. The Americans average 9 steps higher than the Chinese. Test 7 is a test of general information and consequently most involves language difficulty and knowledge of American life and customs.

3. There are no outstanding differences between the Negroes and the Americans, or the Russians and the Americans.[2]

[2] These racial differences were also studied by measuring the deviations of the special racial groups from the median of a large number of unselected American-born students. A large number of native white American Freshmen were taken to represent the Americans (300 on

The results are presented in table 2. From this table is seen that on Test 1, Forms 3 and 4, the Chinese group is 0.13 sigma below that of the Americans. On Test 1, Forms 5 and 6, the Negroes and Russians are 0.30 and 0.16 sigmas below that of the Americans. The results evidently confirm the findings in table 1. This method is considered less satisfactory, however.

CONCLUSIONS

The writer's data suggest the following conclusions:

1. The Chinese test low because they are handicapped by language difficulty.

2. In the case of the Negroes and Russians, the language factor is not so appreciable.[3] The results from these two groups show no distinctive features: there is only a general slight inferiority.

3. The language difficulty involved, in studying racial groups, not thoroughly Americanized as to language by means of verbal intelligence tests, is quite noticeable. One should not, therefore, draw any definite conclusions concerning the relative intelligence of such groups and Americans unless there is some control of the language factor. The test of number series appears to be a good test to use in such studies, since it appears less affected by such influences. Non-verbal and performance tests

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Forms 3 and 4 and more than 2000 on Forms 5 and 6). These scores were next tabulated and the means of all tests were found. The sigmas of all tests were next calculated. The means of all tests for the special racial groups were found. Finally, the means of these racial groups were subtracted from the respective means of the American group. The remainders were divided by their respective sigmas. The quotients were the difference of the two groups in terms of sigma. For instance:

Mean of Test 1 for Americans.....	10	
Mean of Test 1 for Chinese.....	5	
Sigma of Test 1 for Americans.....	20	
10–5.....	5	remainder
Remainder/sigma or 5/20.....	0.25	sigma difference

[3] No evidence was obtainable as to how long those born in Russia had been in this country. It appears probable that most of them had been here since an early age and were thoroughly Americanized as regards language.

might be constructed so as to be more equally valid for several or all races.

4. There is need for more comparisons between races in their home countries, and comparisons involving more unselected and representative groups. The Chinese in the University are a selected group; their superiority on Test 5 is by no means to be understood to mean that the Chinese as a whole will be superior to the Americans as a whole on Test 5. The Russian immigrants are not probably representatives of their home folks. The American college Negroes, too, are not representatives of the Negro race in this country, not to speak of the Negro race as a whole.

I am much indebted to my teacher, Dr. S. L. Pressey, for his valuable aid.

VALUE OF WHITE SPACE IN ADVERTISING[1]

EDWARD K. STRONG, JR.
Stanford University

White space is used to isolate an advertisement and so secure for it greater attention-value.

There is no question that the effectiveness of an advertisement is increased through the use of white space. But it is a serious question whether the increased effectiveness is worth the increased cost.

For instance in a certain advertisement two-thirds of the entire area is white space surrounding the one-third upon which appears the copy. If the space cost $1000, then $667 was spent only in getting attention. Was this expenditure justifiable? Did three times as many persons read the advertisement as would have done so if only one-third of a page had been used? Or, taking into account the number who read the advertisement and the impression made upon them, was there all told three times greater effect produced?

Fifteen years ago very little stress was laid upon the use of white space as an effective device. In fact at that time it

[1] The results of experiments I and II were obtained while the writer held a Research Fellowship in Advertising at Columbia University and were circulated by the Association of National Advertisers as Research Bulletin No. 1, October 16, 1912. The data in experiment III were secured by R. M. Paynter, Jr., while a graduate student at Columbia University, but have never been published. Experiments IV and V were conducted in 1913 at the request of a publishing house. As a result of their findings the publishers eliminated rules between their advertisements, a practice which is quite general today but was very exceptional then.

As these data on the value of white space are apparently all that are in existence the writer feels they should be given wider circulation at this time.

was more customary to use for this purpose heavy black borders rather than white space. Today the emphasis is reversed, although a minority still prefer black instead of white.

In an attempt to ascertain the relationship that exists between amount of white space used for isolation effect and the number of persons who notice and remember the advertisement, five experiments were performed.

SUMMARY OF RESULTS

1. Additional white space up to 60 per cent of the area of the advertisement itself is profitable.

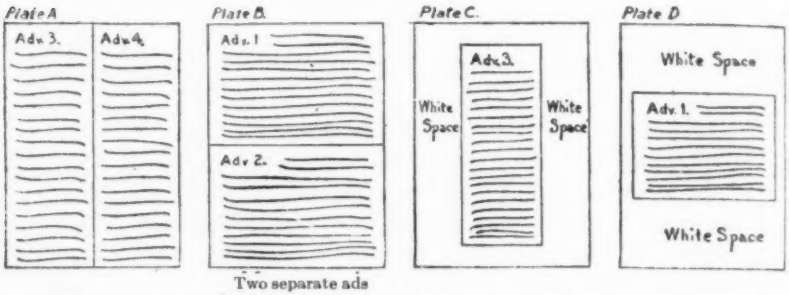

FIG. 1. SHOWING ARRANGEMENT OF ADVERTISEMENTS IN EXPERIMENTS I AND II

2. The greater the additional white space beyond 60 per cent the less profitable is the effect, for beyond that point cost increases faster than attention-value.

3. Twenty per cent increase in space, used as white space around the advertisement, gives the greatest increase in effectiveness, cost considered.

These results are based on a study of $\frac{1}{2}$-page and $\frac{1}{4}$-page advertisements. It is a question whether they apply to full-page advertisements.

I. THE EXTENT TO WHICH $\frac{1}{2}$-PAGE ADVERTISEMENTS CAN BE RECOGNIZED IMMEDIATELY AFTER BEING SEEN

Twenty vertical half-page advertisements and twenty horizontal half-page advertisements were arranged as in plates A

and B of figure 1. These twenty pages were shuffled and shown in succession. The person being tested was then handed eighty half-page advertisements pasted separately on sheets of paper and asked to pick out those he had just seen. Forty of these

TABLE 1

Showing the per cent of individuals that noticed each ad of the 40 when shown two together (experiment I) and when shown separately (experiment II)

VERTICLE HALF-PAGE ADS						HORIZONTAL HALF-PAGE ADS					
Left ads			Right ads			Top ads			Bottom ads		
Ad number	Experiment I	Experiment II	Ad number	Experiment I	Experiment II	Ad number	Experiment I	Experiment II	Ad number	Experiment I	Experiment II
	per cent	per cent		per cent	per cent		per cent	per cent		per cent	per cent
1	22	56	2	51	76	21	20	43	22	18	34
3	43	58	4	40	81	23	29	49	24	47	63
5	25	17	6	54	67	25	43	44	26	35	65
7	36	39	8	51	58	27	36	53	28	28	62
9	25	45	10	39	74	29	28	60	30	17	64
11	22	65	12	57	68	31	33	65	32	15	35
13	47	84	14	17	56	33	21	41	34	33	56
15	30	61	16	27	70	35	43	47	36	28	54
17	45	65	18	25	34	37	20	33	38	14	34
19	31	46	20	24	45	39	18	33	40	27	40
Average...	32.6	53.6		38.5	62.9		29.1	46.8		26.2	50.7
Ratio.....	100–164		100–163			100–161			100–194		

80 advertisements were the ones he had just seen and 40 were new advertisements.[2]

The data are shown in table 1 under the caption "Experiment I." For example, advertisement 1, a vertical half-page ad-

[2] The method of conducting the recognition test and of handling the data is given in the writer's article, "The effect of time-interval upon recognition memory," Psychol. Rev., September, 1913.

vertisement that appeared on the left-hand side of the page, was recognized correctly by 22 per cent of the 10 men and 10 women who were tested. The average left hand, vertical ½-page advertisement was recognized by 33 per cent of the subjects; the right hand, vertical by 38 per cent, the top, horizontal ½-page advertisements by 29 per cent, and the bottom, horizontal by 26 per cent.

II. THE EFFECT OF CENTERING ½-PAGE ADVERTISEMENTS ON A FULL-PAGE

In this experiment the forty half-page advertisements used in experiment I were placed separately on a sheet the size of a magazine page, 20 as shown in plate C and 20 as shown in plate D in figure 1.

The 40 advertisements were shown one at a time to 20 other individuals. The same recognition test was employed as in experiment I.

The data are shown in table 1 under the caption "Experiment II." The ratios at the bottom of this table express the increased attention value attributable to surrounding ½-page advertisements by ½-page of white space. This white space not only helps set off the advertisement but at the same time eliminates the distraction of a second advertisement.

The following results will be noted:

1. The increase in value of a ½-page advertisement in half-page space to a ½-page advertisement in full-page space is not proportional to the increased cost of the space. Instead of a ration of 100–200 we have 100–174, the average of 100–169, 100–163, 100–179 and 100–192.

2. The use of white space benefits good advertisements more than it does poor advertisements. As each of the forty ½-page advertisements were shown separately and centered on a full-page in experiment II, the data therefrom gives a measure of the attention and memory value of the advertisements. When grouped into four groups of ten advertisements each we have:

Advertisements recognized by form:
17 to 41 per cent, ratio 100–155
43 to 56 per cent, ratio 100–159

56 to 65 per cent, ratio 100–188
65 to 84 per cent, ratio 100–166

This result is unexpected. One would suppose that the poor advertisements would benefit more from elimination of distraction, often the elimination of a very good advertisement, than would good advertisements.

3. Vertical $\frac{1}{2}$-page advertisements secure greater attention-value than horizontal $\frac{1}{2}$-page advertisements. The bottom horizontal advertisement is less effective than the top. A possible explanation of these results is illustrated in figure 2. Apparently the nearer the optical center of a small advertisement

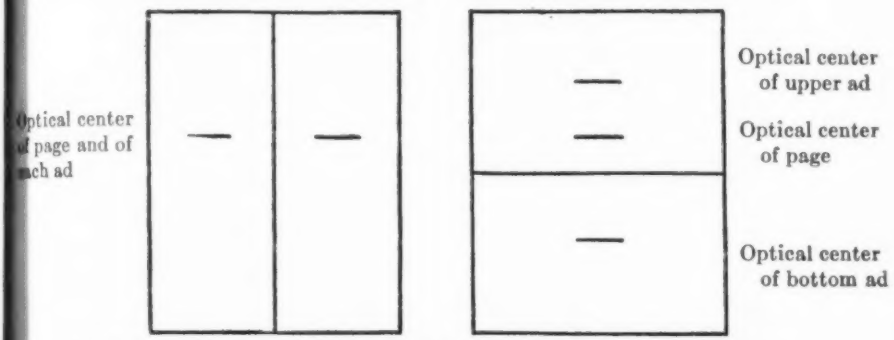

FIG. 2. SHOWING THE RELATIONSHIP BETWEEN THE OPTICAL CENTER OF THE WHOLE PAGE AND THAT OF THE DIFFERENT SHAPED HALF PAGE ADS

is to the optical center of the page the greater is the chance the advertisement will be seen. Another factor that contributes to the effectiveness of vertical $\frac{1}{2}$-page advertisements is the ease with which the eye follows the type of narrow columns. But this factor could not have influenced the data here as the advertisements were not exposed long enough for the person to do more than read the headings and take in the illustrations and general lay-out effect.

III. THE EFFECT OF CENTERING $\frac{1}{4}$-PAGE ADVERTISEMENTS ON A FULL-PAGE

The same procedure was followed here as in experiments I and II except that $\frac{1}{4}$-page advertisements were used instead of

$\frac{1}{2}$-page advertisements. In the first part four $\frac{1}{4}$-page advertisements were shown and then tested by the recognition method. In the second part the $\frac{1}{4}$-page advertisements were shown one at a time centered on a full-page.

The results are given in table 2.

Evidently using $\frac{3}{4}$ of the area of an advertisement as white space around the remaining $\frac{1}{4}$ area is an inefficient procedure. The cost is increased 4 times and the attention and recognition-value only $2\frac{1}{2}$ times.

TABLE 2

	PER CENT	RATIO
Extent to which a $\frac{1}{4}$-page ad was recognized when shown with three others	20.9	100
Extent to which a $\frac{1}{4}$-page ad was recognized when shown, centered on a full-page	52.6	251

TABLE 3

	EXPERIMENT I	EXPERIMENT IV	RATIOS
	per cent	*per cent*	
Vertical $\frac{1}{2}$-page ads:			
Ads on left hand side	32.6	35.4	100–109
Ads on right hand side	38.5	42.3	100–110
Horizontal $\frac{1}{2}$-page ads:			
Ads on upper half of page	29.1	41.0	100–141
Ads on lower half of page	26.2	25.5	100– 97
Average	31.6	36.0	100–114

IV. THE EFFECT OF SEPARATING $\frac{1}{2}$-PAGE ADVERTISEMENTS BY $\frac{1}{2}$-INCH, INSTEAD OF $\frac{3}{16}$-INCH, OF WHITE SPACE—A HAIR LINE RULE BEING USED IN BOTH CASES

The $\frac{1}{2}$-page advertisements were separated from each other in experiment I by approximately $\frac{3}{16}$-inch of white space. This white strip was divided by a hair-line rule such as is used between columns of copy in a newspaper and between advertisements in some publications.

In experiment IV, the white strip was widened to ½-inch; a rule also being used as in experiment I. The advertisements were tested in the same manner as in experiment I. The data are shown in table 3

In this case we have added $\frac{5}{32}$-inch to the width of each of the two advertisements ($\frac{1}{2}$-$\frac{5}{16}$ /2). This amounts to an increase of 5.7 per cent in the case of the vertical advertisements and 3.8 per cent in the case of the horizontal advertisements, or an average of 4.75 per cent. With this increase of 4.75 per cent there is a resulting gain in attention and recognition value of 14 per cent.

The addition, then, of a small amount of white space between advertisements is an effective method of increasing their value, cost considered.

TABLE 4

	EXPERIMENT IV	EXPERIMENT V	RATIOS
	per cent	*per cent*	
Vertical ½-page ads:			
Ads on left hand side	35.4	36.0	100–102
Ads on right hand side	42.3	45.2	100–107
Horizontal ½-page ads:			
Ads on upper half of page	41.0	39.6	100–97
Ads on lower half of page	25.5	29.7	100–116
Average	36.0	37.6	100–104

V. EFFECT OF USING OR NOT USING A RULE BETWEEN ½-PAGE ADVERTISEMENTS

Another set of advertisements, identical with those used in the above experiments, was presented to a new group of twenty men and women. In this case the advertisements were shown separated by ½-inch of white space but with no rule. The only difference, accordingly, between experiments IV and V was the presence of a rule in the first case and the absence of a rule in the second. Table 4 shows the data.

Experiments IV and V were run years ago at the suggestion of the manager of a prominent engineering magazine, who was

considering the advisability of discontinuing the use of rules between his advertisements in order to improve the appearance of the publication. He was fearful that elimination of the rule would lower the attention-value of the advertisements as they would tend, he thought, to fuse together. The experiment justified the change showing that white space alone was better

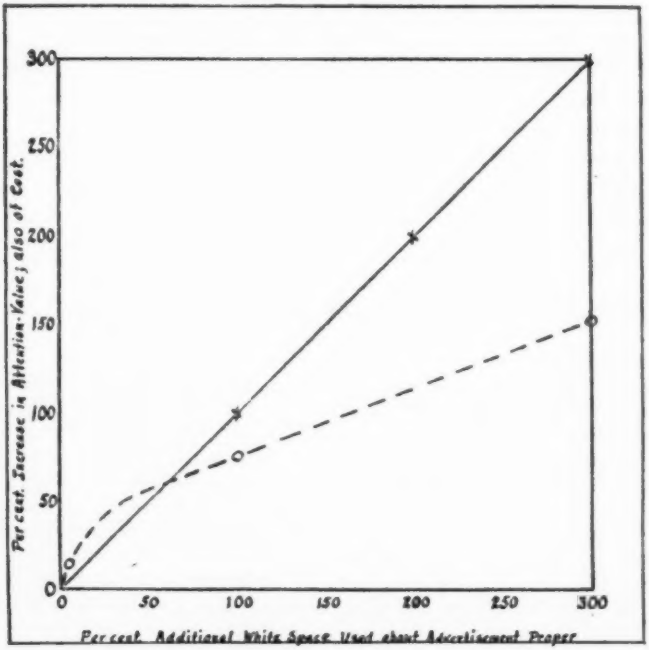

FIG. 3. SHOWING EFFECT OF USING ADDITIONAL WHITE SPACE ADVERTISEMENTS IN TERMS OF COST (STRAIGHT LINE) AND OF ATTENTION-VALUE (DASHED LINE)

in keeping advertisements apart than white space divided by a rule.

When we look at a full-page advertisement we first comprehend it in its entirety. After the first glance, if so inclined, we proceed to take in the details one after another. This is the case if the advertisement is a good one. If it is a poor advertisement, lacking unity, we are forced to take in the several parts

and then attempt to put them together. In the case of a page with many advertisements upon it, we are helped greatly if they are so displayed that each advertisement stands out separate from the rest. Then each can be reacted to easily as a whole; and later in detail, if we are interested. Apparently there is no better way of separating advertisements on a page, or the separate items within a department store advertisement, than to use white space between them. Rules and borders do not isolate as effectively as white space.

VI. CONCLUSION

In experiment II we found that doubling the area of an advertisement increased the attention and recognition-value by 76 per cent; in experiment III we found that quadrupling the area increased the value by 151 per cent; and in experiment IV we found that increasing the area by 5 per cent increased the value by 14 per cent. The relationship is shown in figure 3.

From these data it would appear that the effectiveness of a small advertisement can be profitably increased by buying more space and using this additional area as white space around the advertisement. It would appear that this statement is true as long as the additional space does not exceed 60 per cent of the area of the advertisement proper. If more than 60 per cent is used the increased cost will not be compensated for by a corresponding increase in attention-value. Furthermore, about 20 per cent additional area used as white space about the advertisement gives the greatest increase in effectiveness, cost considered.

This conclusion may be explained by assuming that the use of white space secures increased attention-value by (1) separating one advertisement from another[3] and (2) by increasing the size of the advertisement. The first factor is accomplished by a small amount of white space, certainly by 40 per cent or less.

[3] Further studies should be made using advertisements smaller than ¼-page; also with varying widths of white space between advertisements. The procedure employed here might well be used in various studies of distraction.

The second factor never pays at all. Studies by several investigators show that attention value increases nearly as the square root of the increase in area and not directly with the increase in area.

Another use of white space is to give dignity, prestige effect. This use is well illustrated in the advertising of Tiffany. It is quite likely that this concern secures sufficient value in terms of prestige to pay for the excessive amount of white space they employ. But if ten of their competitors commenced using this unusual lay-out also it is very doubtful if any of them, including Tiffany, would secure sufficient value to compensate for the cost.

CORRECTNESS OF JUDGMENTS BASED ON SENSATION INTENSITIES AND TIME ALLOWED FOR MAKING JUDGMENTS

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The object of this investigation is to determine the relationship of sensation intensities to time permitted for making judgments.

Experiments have been carried out with graduated sensation intensity stimuli in discrimination in brightness of grays, with the object of testing time relationship to judgments on the intensive scale of graduated stimuli.

Twenty subjects were used in the experiment, 10 men and 10 women, from the senior class and the Graduate School of the University of Texas. The apparatus was set up in the Psychological Laboratory of the University of Texas, under the direction of Dr. F. A. C. Perrin.

The apparatus for the Experiment consists of the following: A set of ten test-cards, a Graflex Focal Plane Shutter, and a pendulum time marker. Each card consists of two gray strips, 13 by 40 mm., on a white background, 10 by 10 cm. The cards were numbered from 0 to 9, corresponding to 10 different pairs of stimuli. Each card contained one strip of the lightest or standard gray and one strip of comparison gray. The card marked 0 contained no difference. The card marked 1 contained the minimal objective difference; and from 1 through 9 there was a graduated increase in the shade of gray, card 9 containing the maximal objective difference. Each card was numbered on the back in such a way that, when looking at the face of the card with the number up, the right strip is the darker.

The Graflex Focal Plane Shutter was an instrument so fixed that the cards could be exposed by pressing a button on the end of a string that was connected with the winding spring of the apparatus, and by pressing a button a second time the exposure of the card was shut off. Another card was then placed in the apparatus, the winding spring was turned twice by the observer, and another card was ready for exposure.

The pendulum time marker was used in the experiment.

The method of procedure for this experiment was as follows: The subjects were placed in front of a small table located in a north room, which had two windows, one giving a north exposure and the other a west exposure. The table was situated between the two windows, and at the right of it was another table on which was placed the pendulum. The Graflex Focal Plane Shutter was placed on the table and so arranged as to be directly in front of the eyes of the subjects who were seated with their backs to the windows and with their faces toward the gray walls of the experiment room. The test cards were kept on the table in front of the subjects but out of their vision.

The experiment was first explained to the subjects; the apparatus was next explained, and this was followed by a series of preliminary trials in order to get the subjects acquainted with the manipulation of the apparatus in the experiment. The subjects having been acquainted with the apparatus, they were next instructed that they were going to be tested for their stimulus limen. They were told that the darker shade of gray would be given on their right side and that when they perceived this difference they should report. Cards were then given beginning at zero and going up the stimulus scale. When the subjects reported a difference, the number of the card was noted, and a check was given on this number by beginning at the last card in the series and going toward the first. The card was noted at which the subjects reported no difference and compared to their first card. A still further check was given by presenting the cards in a haphazard order. After the stimulus limen was determined, the subjects were presented the

TABLE 1

Group I, order I

SUBJECT NUMBER	NUMBER OF TRIALS	1	2	3	4	5	6	7	8	9	10	c	oc
I	1	R R	R L	L L	L L	L L	R R	R R	R R	L L	L R	8	8
	2	R R	R R	L L	L L	L L	R R	R R	R R	L L	L L	10	9
	3	R L	R L	L R	L R	L R	R L	R L	R L	L R	L R	0	7
		1	1	½	1	1	½	½	½	½	½		
II	1	R	R	L	L	L	R	R	R	L	L	10	8
	2	R	R	L	L	L	R	R	R	L	L	10	9
	3	R	R	L	L	L	R	R	R	L	L	10	7
		3	½	½	½	½	1	½	1½	1	1		
III	1	R	R	L	L	L	R	R	L	L	L	9	8
	2	R	R	L	L	L	R	R	L	L	L	9	9
	3	R	R	L	L	L	R	R	R	L	L	10	7
		1	2	2	1	2	2	½	½	½	½		
IV	1	R	R	L	L	L	L	L	R	L	L	8	2
	2	L	L	L	L	L	L	L	L	L	L	5	3
	3	L	L	L	L	L	R	R	R	R	R	6	1
		2	6	3	½	½	2½	½	1½	2	½		
V	1	R	R	L	R	R	R	R	R	L	R	7	7
	2	L	R	R	L	L	R	L	R	L	R	6	8
	3	L	L	R	R	R	R	R	R	R	R	3	6
		1½	½	½	1½	½	½	1½	½	½	½		
VI	1	R	R	L	L	L	R	R	R	L	L	10	5
	2	R	R	L	L	L	L	R	L	L	L	8	6
	3	R	R	L	L	L	R	R	L	L	L	9	4
		1	2	6	2	2	1	2	2	1	1		
VII	1	L	L	L	L	L	R	R	R	L	L	8	6
	2	R	R	L	L	L	R	R	R	L	L	10	7
	3	L	L	L	L	L	R	R	L	L	L	7	5
		3	3	2½	3	4	3	3	3	½	1		
VIII	1	R	R	L	L	L	R	R	R	L	L	10	6
	2	R	R	L	L	L	R	R	R	L	L	10	7
	3	R	L	L	L	L	L	L	R	L	R	6	5
		2	3	2	½	2	5	3	4	2	2		

TABLE 1—*Continued*

SUBJECT NUMBER	NUMBER OF TRIALS	1	2	3	4	5	6	7	8	9	10	C	OC
IX	1	L	R	L	L	L	L	R	L	L	L	7	6
	2	L	L	L	L	L	R	R	L	L	L	7	7
	3	L	L	L	L	L	R	L	R	L	L	7	5
		1	1	1	2	3	1	2	3	1	3		
X	1	R	L	R	L	L	R	R	L	L	L	7	5
	2	R	R	L	L	L	R	L	R	L	L	9	6
	3	L	R	R	L	L	L	R	R	L	L	7	4
		2	2	2	1	1	1	2	1	1	1		

limen card, the card below the limen, and the card above the limen.

The subjects were divided into two groups of 10 subjects each, the order of cards and time being reversed on the second group.

Beginning at the right in table 1, the Roman characters stand for the subjects. In the next column are figures 1, 2, and 3, which represent the number of trials each subject made. The figures at the top of the page, from left to right, represent the number of tests in each trial. The first letter in each column from left to right represents the position in which the card was placed in the Graflex Focal Plane Shutter. The letter in the next column represents the judgment made by the subjects. In the last column on the right C represents correct judgments and OC represents the way the cards were presented.

One second of time was given with the judgments running parallel with 1, two seconds of time was given with the judgments running parallel with 2, and for the judgments running parallel with 3, the time taken is indicated by a figure under the judgment.

With table 1, group I, order I, the first trial was made with the column running parallel with 1, the second trial was made with the column running parallel with 2, and the third trial was made with the column running parallel with 3.

The stimulus limen was given first, the one above the stimulus

TABLE 2

Group II, order II

SUBJECT NUMBER	NUMBER OF TRIALS	1	2	3	4	5	6	7	8	9	10	c	oc
I	1	R R	R R	L L	L L	L L	R R	R R	R R	L L	L L	10	7
	2	R	R	L	L	L	L	L	R	R	L	7	8
	3	R	R	L	L	L	R	R	R	L	L	10	6
		1	1	1	½	½	½	½	½	½	½		
II	1	R	R	L	L	L	R	R	L	L	L	9	7
	2	R	R	L	L	L	L	L	R	R	L	7	8
	3	R	R	L	L	L	R	R	R	L	L	10	6
		1	1	½	½	½	½	½	½	½	½		
III	1	R	R	L	L	L	R	L	L	R	L	7	8
	2	R	R	L	L	L	L	R	R	R	L	8	9
	3	R	R	L	L	L	R	R	R	L	L	10	7
		1	1	1	½	½	½	½	½	½	½		
IV	1	L	R	L	R	L	R	L	R	R	I	6	2
	2	L	R	L	L	L	R	R	R	L	L	9	3
	3	R	L	L	L	L	L	L	L	R	I	5	1
		2	1	2	1	1½	½	1	1	1	1		
V	1	R	R	R	L	R	R	R	R	R	R	6	7
	2	R	R	L	L	L	R	R	R	L	I	10	8
	3	L	R	L	L	L	R	R	R	R	R	7	6
		1	3	1	1	2	1	2	1	1	1		
VI	1	L	R	L	L	L	R	R	R	R	I	8	2
	2	R	L	L	L	R	R	L	L	R	R	4	3
	3	R	R	L	R	L	L	L	R	L	L	7	1
		7	7	5	5	9	5	5	6	10	6		
VII	1	R	L	L	L	L	R	R	R	L	L	9	6
	2	R	R	L	L	L	R	R	R	L	L	10	7
	3	R	R	L	L	L	R	R	R	L	L	10	5
		3	2	1	1	1	1	1	½	1	1		
VIII	1	L	R	L	L	L	R	L	L	R	R	5	4
	2	L	R	R	L	L	L	R	R	L	R	6	5
	3	L	L	L	L	L	L	L	R	L	R	5	3
		5	2	1	2	1	2	2	2	1	2		

TABLE 2—*Continued*

SUBJECT NUMBER	NUMBER OF TRIALS	1	2	3	4	5	6	7	8	9	10	c	oc
IX	1	R	R	L	L	L	R	R	L	L	L	9	6
	2	R	R	L	L	R	R	R	R	L	L	9	7
	3	R	R	L	L	L	R	R	R	R	L	9	5
		½	½	½	½	½	½	½	½	½	½		
X	1	R	R	L	L	L	R	R	R	L	R	9	5
	2	R	R	L	L	L	R	R	R	L	L	10	6
	3	R	R	L	L	L	R	R	L	L	L	9	4
		1	1	1	1	1	1	1	1	1	1		

limen was given second, and the one below the stimulus limen was given third.

The order and time were reversed in table 2 by beginning with the trial parallel to the figure 3. Subjects were allowed all

TABLE 3

Group I, order I—accuracy table discrimination of grays

	F	I	S	JUDS					
1	1	2	0.70	10	0	2	0	10	8
2	1	2	1.00	0	0	0	10	10	10
3	1	2	1.20	0	1	1	10	9	9
4	1	2	1.90	4	5	2	6	5	8
5	1	2	0.80	7	4	3	3	6	7
6	1	2	2.00	1	2	0	9	8	10
7	1	2	2.60	3	0	2	7	10	8
8	1	2	2.55	4	0	0	6	10	10
9	1	2	1.80	3	3	3	7	7	7
10	1	2	1.40	3	1	3	7	9	7
Totals	10	20	15.95	35	16	16	65	84	84
Totals divided by 10	1	2	1.595	3.5	1.6	1.6	6.5	8.4	8.4

of the time that they wished for making their first judgments, and with this time they were given a card one number below the stimulus limen. The next trial they were given the column parallel to the figure 2 with 2 seconds with which to make this

judgment, and with this judgment they were given the card that was found to be their stimulus limen. The third trial they were given the column parallel to figure 1 with only one second in which to make judgments. This same procedure was followed for each subject in the group, care being taken to see that standard conditions prevailed for each subject.

Table 3, group I, order I, goes with the first group of 10 subjects in the experiment. Beginning at the left and going to the right, the first column represents the number of subjects; the column under F represents the fast time, which is one

TABLE 4

Group II, order II

	S	I	F	JUDS					
1	0.65	2	1	0	3	0	10	7	10
2	0.60	2	1	0	3	1	10	7	9
3	0.65	2	1	0	2	3	10	8	7
4	1.20	2	1	5	1	4	5	9	6
5	1.70	2	1	3	0	4	7	10	6
6	6.50	2	1	3	6	2	7	4	8
7	1.25	2	1	0	0	1	10	10	9
8	2.00	2	1	5	4	5	5	6	5
9	0.50	2	1	1	1	1	9	9	9
10	1.00	2	1	1	0	1	9	10	9
Totals	16.05	20	10	18	20	21	82	80	78
Totals divided by 10	1.605	2	1	1.8	2	2.1	8.2	8	7.8

second; the column under I represents the intermediate time, which is two seconds; the column under S represents the slow time, which signifies that the subjects took all of the time they wished for making judgments. The first three columns under Juds represent the wrong judgments made. The last three show correct judgments made. The columns on the left in both right and wrong judgments go with fast time, the columns in the middle of both right and wrong judgments go with the intermediate time, and the last columns in both right and wrong judgments go with slow time, or the time in which the subjects

were at their leisure to make judgments. Parallel with Total is given the sum of each column, which is divided by 10, giving the average times and the average judgments of the experiment.

TABLE V

Accuracy Curve in Discrimination of Grays

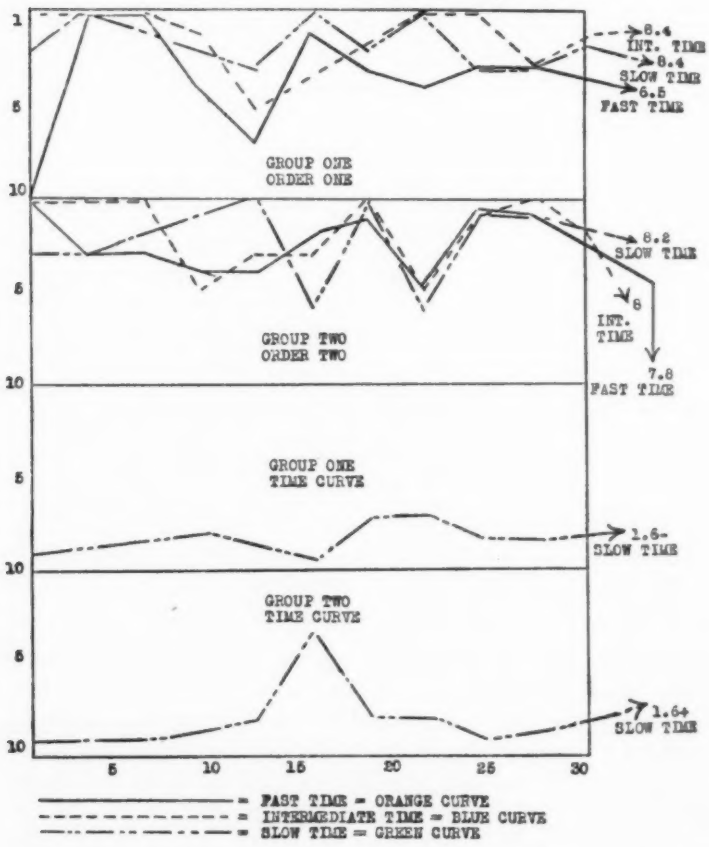

Table 4, group II, order II, go with the second group of 10 subjects in the experiment.

The results of experiment two are found in tables 3 and 4

and a graph of the results in table 5. The judgments in the column parallel with figure 1 are made by the first subjects, those in the column parallel with two by the second subjects, and those in the column parallel to the number 3 by the third subject, etc., throughout tables 1 and 2.

Table 5 is divided into four equal divisions, the ordinate of each division representing 10 subjects and the abscissa of each division representing 30 trials. Only one abscissa is numbered, but the abscissa of each divison is supposed to be numbered just exactly like the one at the bottom of the page. Each ordinate of each division is numbered separately; and as each subject had three trials and a different time for each trial, it was necessary to make a graph for each subject in the ratio of 1:3, that is, one unit was allowed on the ordinate while three units were allowed on the abscissa.

The accuracy curve in group I, order I, corresponds to table 1, group I, order I. The orange curve represents the fast time; the green curve represents the slow time; and the blue curve represents the intermediate time. This is true for both group I, order I, and group II, order II. Group I, time curve, goes with group I, order I. Group II, time curve, goes with group II, order II.

For the fast time in group I, order I, there were 6.5 correct judgments made out of 10 judgments. For the intermediate time there were 8.4 correct judgments made out of 10. For the slow time there were 8.4 correct judgments made out of 10. For the fast time in group II, order II, there were 7.8 correct judgments made out of 10. For the intermediate time there were 8 correct judgments made out of 10. For the slow time there were 8.2 correct judgments made, and by slow time we always mean that the subjects were given all the time that they desired for making judgments. This does not mean that the subjects took longer to make their judgments; for as is shown all throughout this experiment, the subjects made judgments in less time than they were given in the intermediate time.

The results of this experiment point out a relation of sensation intensity and time permitted for making judgments,

which seems to be a cognitive process and not merely reaction to a stimulus. This was brought out in the following manner. The stimulus limen was given with the fast time in group I, which was one second. This proved to be too short, as only 6.5 correct answers were given out of 10. (This was an average for the entire group of ten subjects.) A card one number above the stimulus limen was given with the intermediate time, which was two seconds of time. The increased time and the increased stimulus made a difference. Of 10 answers 8.4 were correct, making a difference of 1.9. A card one number below the stimulus limen was given, and the subject had all the time desired to make judgments. The average time taken by the group was 1.6 seconds; and with this time 8.4 correct judgments were made out of 10, making a difference of 1.9. One second of time was found to be too short. The time for the greatest number of correct judgments for the first group was between 2 and 1.6 seconds, and this time was given, or rather taken, by the subject with a card one number below the stimulus limen.

An interesting thing brought out in this test is that if you give the subjects their own time to make judgments when testing for the stimulus limen, they take much longer than they do after starting the experiment. For this reason it was necessary to give all of the subjects one standard time when searching for the stimulus limen. The standard time chosen was three seconds. This accounts for the accurate reports on the card below the card selected as the limen by the subject; for when the subjects deliberated too long they were more likely to go wrong than when they made their judgment instantaneously or in a little less than a second and a half. In other words, the experiment shows that there are different limens with different times and the first judgment with each limen and time is the more correct. A long deliberation meant error.

When we turn to group II, order II, we find the same relationship. Although the order of the stimuli cards and the time was reversed, there was no appreciable difference. The slow judgment was given first with card one below the stimulus limen, and 8.2 correct judgments were made out of a possible

10. The time selected by the subjects was 1.6+ seconds. The intermediate time, or two seconds, was given with a card one number above the limen selected by the subject; and 8 correct judgments out of a possible 10 were given, a decrease of 0.2. The stimulus limen was given with the fast time, and 7.6 correct judgments out of a possible 10 were made.

The time curves averaged the same for both group I and group II, the average being 1.6 seconds for making judgments. The curves are made from the average time when the subjects in the respective groups took all of the time that they wished for making judgments. The curves for one and two seconds are not drawn, as the curves for a standard unit of time make a straight line.

This investigation seems to establish a cognitive process in response to stimuli without regard to the graduated scale of sensation intensity stimuli.

The process appears to reduce itself to perception, and perception has that little warmth of intimacy about it that is not found in sensation. The simplest kind of perception, pure perception, implies the grouping of sensations under the laws of attention. But they seem to be made up of more than sensations, since we see, feel, and hear more than is perceived to the eye, skin, and ear. The sensations gotten from the stimuli are supplemented by images, and the perceptions become mixed perception, including complexes of sensory and imaginal elements.

The data demonstrate that when the selected scale of sensation intensity stimuli was presented to the subjects, the sensations became perceptions. But that is not all; the perception had meaning. No sensation means; a sensation simply goes on in various attributive ways, spatially, clearly, intensively, etc. All perceptions mean: they go on also in various attributive ways, but they go on meaningly.

From a psychological standpoint meaning is always context; one mental process is the meaning of another mental process if it is that other's context. And context, in the sense used here, is simply the mental process which comes as a natural result to the given process through the situation in which the subject

finds himself. At first, the situation is physical and external, and originally the meaning is kinaesthesis. The subject faces the situation by a bodily attitude; and the characteristic sensations which the attitude arouses give meaning to the process which stands to the conscious focus; and they are therefore psychologically the meaning of the process. The situation may be either external or internal, either physical or mental, either a group of adequate stimuli or a constellation of ideas. Image has now supervened upon sensation, and meaning can be carried into imaginal terms. Therefore, meaning for us may be mainly a matter of sensations of the special senses, or of images, or of kinesthetic or other organic sensations, as the situation under which we are placed demands.

But in order to have meaning there must be two sensations. When the sensation of it is accompanied by a strain, it becomes a perception of color in the place of a mere reaction to stimulus. It becomes *that gray something;* and it owes the *that something* to the strain content. However, meaning is not always conscious; it may be carried in purely psychological terms. A word, facial expression and inflection of the voice, a bodily attitude, a stimulus of any kind may press the nervous button, and consciousness is turned, unknowingly, into new channels.

Therefore, the graduated sensation intensity stimuli of grays appear to become sensory complexes with kinaesthetic settings and not simple reactions. The sensory complexes pass over into complex perceptions and the complex perceptions resolve themselves into the cognitive process and not merely reaction to stimuli. The process is that of comparing, not merely that of reacting to external objects.

There is a differentiation of the various sensations, and with this a certain time is required before passing judgments on the stimuli presented.

The time relation seems to be established through the cognitive process and not through the graduated stimuli.

NOTES AND NEWS

GODSEY LATIN COMPOSITION TEST

The World Book Company announces the publication of the Godsey Latin Composition Test. The aim of this test is to gauge the accuracy of Latin composition work at the same time showing the correlation of sentence-writing skill to knowledge of Latin grammar. It was devised and administered to many thousands of students in the nation-wide survey conducted by the American Classical League in 1921–1923 and is now published for general distribution. Norms are furnished, based upon 20,000 cases. The test requires about thirty-five minutes and any teacher of Latin can quickly learn to use it.

COLUMBIA HONORS DR. THORNDIKE

The Alumni Home Coming Day, February 19, 1926, of Teachers College, Columbia University, celebrated the twenty-fifth year of service rendered that institution by Dr. Edward L. Thorndike. The program consisted of addresses by Dr. Charles H. Judd, of University of Chicago on "A Century of Applications of Psychology to Education;" Dr. Agnes Rogers, Bryn Mawr College, on "The Contribution of Psychology to Child Welfare;" and Dr. Thorndike, on "The Psychology of Adult Learning." Following the program Dean and Mrs. Russell gave a reception to returning Alumni, officers of Teachers College, graduate and senior students and their friends.

INDUSTRIAL PSYCHOLOGY WELCOMED

THE JOURNAL OF APPLIED PSYCHOLOGY extends a cordial welcome to *Industrial Psychology*. This is a monthly journal having published its first issue in January, 1926. Striving as it does to bring results of modern psychology in the field of industry in popular form to those engaged in this work we wish for it every success. Under the vigorous and able leadership of Dr. Laird it should render most valuable service. From an examination of the first three issues we believe that it has made a very promising start. Those interested should address the Editor, Industrial Psychology, Hamilton, N. Y.

YALE STERLING FELLOWSHIPS

The Sterling Fellowships have been established by a gift of One Million Dollars from the Trustees of the Estate of the late John W.

Sterling to stimulate scholarship and advanced research in all fields of knowledge. They are open equally to graduates of Yale University and other approved colleges and universities in the United States and foreign countries, to both men and women, whether graduate students, or instructors or professors when on leave of absence who desire to carry on studies and investigations under the direction of the Graduate Faculty of Yale University or in affiliation with that body.

The Sterling Fellowships are divided into two general classes: Research or Senior Fellowships and Junior Fellowships. Candidates for Research or Senior Fellowships must have the Ph.D. degree, or must have had such training and experience in research as are indicated by this degree. Candidates for Junior Fellowships must be well advanced in their work towards the Ph.D. degree. These Fellowships are awarded on the understanding that the recipients shall not engage in teaching during the tenure of appointment.

The stipends of the Research or Senior Fellowships range from $1000 to $2500 or more, dependent upon the character of the proposed investigation. The stipends of the Junior Fellowships range from $1000 to $1500. For special purposes, such as carrying through to completion a piece of investigation, awards may be made of less than $1000.

Application blanks should be addressed to the Dean of the Graduate School of Yale University, New Haven, Connecticut.

COMMONWEALTH FUND GRANTS ANNOUNCED

Gifts for scientific, educational, and humanitarian work totalling $1,339,000, made by the Commonwealth Fund, of New York City, during the fiscal year ending September 30, 1925, were recently announced in the seventh annual report of the General Director, Barry C. Smith.

The endowment of the Fund, which was established in 1918 by gift of Mrs. Stephen V. Harkness, totals at present $38,761,000. Child welfare has been one of the chief interests of the Fund, involving grants to many different organizations in this field. The most recent enterprise of the Fund is a program of establishing hospitals in rural communities in the South. Special grants during the past year were made to the American Society for the Control of Cancer, Foreign Language Information Service for Americanization work, the Hunan-Yale College of Medicine in China, the National Association of Travelers Aid Societies, and many others.

PERSONNEL RESEARCH FEDERATION

During the past academic year the Personnel Division of the American Council on Education in Washington, D. C., received 440 calls for teachers. This shows an increase of 300 per cent over the previous

year indicating the rate at which interest and confidence in the enterprise is spreading. The Personnel Division is being conducted on a high professional plane, charging no fees or commissions to registrants. An organization which is thus beneficial to teachers and executives, which operates on a national scale and within a limited budget can do its best work only as a coöperative enterprise. All college teachers and all graduate students preparing to teach in college are urged to register.

THE MODERN FOREIGN LANGUAGE STUDY

The Modern Foreign Language Study, under the auspices of the American Council on Education, expects to carry on extended research work during the present year involving a number of controlled experiments in the class-room and the wide administration of achievement tests. Among these tests of linguistic ability which in many cases will be necessary to construct in the four languages concerned, French, German, Italian and Spanish, are a Vocabulary Test, Silent Reading Test, a Translation-into-English-Test, a Written Composition Test and several others.

Two bulletins have been published by the Committee on Direction and Control which set forth the immediate and ultimate aims of the Study, as well as a list of problems for investigation and research. It is hoped that modern language teachers in colleges and universities will avail themselves of these bulletins and give consideration to the problems in the assignment of master's and doctor's theses. Those interested in the work may secure the bulletins by writing to The Modern Foreign Language Study, 561 West 116th Street, New York City.

BOOK REVIEWS

DONALD A. LAIRD. *The Psychology of Selecting Men.* McGraw-Hill Book Company, New York, 1925. 274 pp. Price $3.00.

Dr. Laird gives an animated presentation of the difficulties and methods of employment psychology. The positive advances in this field seem for the time being to have reached a plateau so that recent volumes on the subject deal with a more or less familiar content. The outstanding merit of the present book is in the variety of "teaching aids" it utilizes and in its castigation of the fakir.

Problems are not merely described—they are also concretely set before the reader in some apt and diverting manner. After chapters on individual differences and the difficulties these provide in selection, some of the traditional methods of selection are reviewed critically. The rôle of the charlatan is vigorously exposed, accompanied again by concrete samples,—reproductions of fakir advertisements and announcements which are denounced in no mincing terms.

Useful sections are presented on ways to find a reputable psychologist and his characteristics when found. The road to scientific psychology is made so plain that the reader, though an employment expert, need not err therein.

The usual topics such as interview, rating scales, production records tests, statistical techniques, and the like, are discussed and illustrated by very suggestive charts and graphic devices. Tests are not given the position to which they have aspired in employment psychology and the psychologist's chief contributions appear in the form of statistical analysis.

Great freedom is exercised in the use of the work of others and the professional student will regret the inadequate documentation of most of these off-hand reproductions.

The volume should prove valuable to the employment man by giving a stimulating notion of the possibilities of development in his own work and by checking his gullibility for unscientific fads. To the teacher it will provide many suggestions of ways to enliven class work in this field.

H. L. HOLLINGWORTH,
Columbia University.

ALBERT T. POFFENBERGER. *Psychology in Advertising.* New York, A. W. Shaw Co., 1925. Pp. 632. $5.00.

Students of the psychology of advertising need no longer spend a

good share of their time in the library searching for isolated articles on the subject. Poffenberger has performed a needed service in summarizing all the work on this topic which has been done by psychologists or through the use of psychological methods. The summaries are both adequate and impartial. It is a pleasure to handle the book for it is well written, well printed and bound and excellently illustrated. Psychologists and students should have it in their libraries for ready reference.

In its general outline the book follows the standard introductory textbooks in psychology. The first chapter presents the psychological attitude toward advertising. Chapters II to VI discuss the appeal, methods of measuring the strength of appeals and desire. Following these are chapters devoted to attention (five chapters), perception, comprehension, feeling (five chapters), memory and association (three chapters), belief and conviction, suggestion, and individual differences. One-fourth of the book is devoted to attention. This is justifiable in Poffenberger's case because psychologists have actually produced more on this topic than any other. Whether the original writers were well advised is another question.

The title "Psychology in Advertising" is nicely phrased for the emphasis throughout is on psychology, not advertising. A truer title would be "Psychology in Advertisements," for the book considers advertisements but hardly the process of advertising. There is very little or no utilization of current thought in advertising circles nor is there much appreciation of advertising as a business force. *Printer's Ink*, for example, is mentioned less often then *The Ladies Home Journal*.

As a rule we psychologists have studied advertisements but not the processes involved behind the advertisements. Little or no investigations have been made of the mental processes of consumers or dealers as such. We have been content to give a list of "instincts" or something of the sort and drop the matter there. Anyone who has attempted to present such a list, in the face of our pitiful lack of knowledge of the subject, must be very reluctant to criticize another's list. But the impression left by Chapter III that such desires as for cleanliness, beauty, economy and hospitality are the "bases of advertising appeals" certainly seems questionable.

Poffenberger recognizes what the reviewer considers the real function of advertising when he writes on page 502, "To have for sale a commodity that will satisfy a real human need, and to show in advertising that it will do so, and to show that it will do so better than any other commodity is to furnish the essential requirement for effective association," and again on page 520, "The most important association or bond that can be established is that between a desire or need and some specific means of satisfying the desire or need." The book is not however built around these concepts of "want," "solution" and "satisfaction" but about the

old faculty psychology concepts of attention, perception, memory and the like. It is true that Chapters II to VI deal with desire, its characteristics, etc., but the reader is not supplied with instructions as to how to use this information. Instead he is launched into the problem of getting attention.

Personally the reviewer feels that here as elsewhere too great and esoteric a significance is attributed to this matter of "attention." It is used to explain too many of the mysteries of advertising. Surely there is no intention to convey the impression that there is a separate force called attention which can move mountains. Possibly in such cases reference has unwittingly been made to the activities of the organism as separate from the stimulus.

When an individual encounters an advertisement two different sets of factors determine his reaction; namely, the advertisement as a stimulus and the individual himself. In studying advertisements as stimuli we conclude that, other things being equal, this or that may be the case. No one can question the ascertained fact, if the procedure was sound. But in such cases we have practically eliminated the most important factor when we said "other things being equal," we have practically eliminated the dynamic organism. As a result psychologists have studied intensively the characteristics of advertising stimuli as they affect human beings, but they have almost ignored the characteristics of human beings as they react to advertisements. Human beings sometimes seek advertisements. Why? They read some advertisements and not others. Why? The complete answers are not to be found by analyzing advertisements but rather in analyzing prospective buyers.

Poffenberger had presumably something of this in mind when he wrote that associations are established through control of attention. "It appears," he says, "that the direction of attention and not spatial relations determined the association" (forward not backward). But let us use some term other than attention in such connections, let us make an endeavor to get at the motives that are involved. When we have done so we will have a far more meaningful and also more usable psychology of advertising.

EDWARD K. STRONG, JR.,
Stanford University.

WILLIAM FREDERICK BOOK. *The Psychology of Skill.* The Gregg Publishing Company, New York, 1925. Pp. 257.

In his second edition of the Psychology of Skill, the author has used the original text except minor changes in numbering chapters and sectional headings. Because of its careful and detailed analysis of the processes involved in the acquisition of skill, this new edition will be welcomed by the students of the psychology of learning. The first edition appeared in 1908 and has been out of print for several years.

In gathering data for the original study, the author employed a two-fold method. By means of carefully constructed apparatus, he made an accurate record of the various physical aspects of the learning process in the case of each of his learners.

To supplement this record of the physical aspects, each learner wrote down from day to day a detailed account of his own mental and emotional activities during the practice periods. These introspections proved to be of great significance in the study of the learning processes. With these two forms of data before him, the author made his interpretations. This is an important phase of the study. Too often our studies in the learning process report only the objective aspects leaving the more subtle and perhaps more essential subjective factors untouched.

The particular form of the acquisition of skill investigated was learning to typewrite. Both the sight and the touch methods were included in the investigation.

The table of contents supplies an excellent outline of the book, and possesses unusual merit. The table of contents together with an adequate index makes it easy to locate and trace any desired aspect or phase of the discussion. There are also numerous cross-references in the body of the text thus making it comparatively easy to follow up the discussion of any topic. Frequent references are also made to literature then current.

A list of the major topics discussed at length follows: Detailed analysis of learning to write by touch; detailed analysis of learning to write by sight; some mental habits acquired in the course of the practice; retention of typewriting skill; how typewriting habits are acquired; phenomena influencing learning and the rate of work: explanation of the learning curves. The book closes with a general summary of the results.

The topic "the acquisition of skill" represents a theme that makes a strong appeal not only to those interested in industrial and mechanical activities but to the educator in general. In these days much of human life is expressed in terms of efficiency or skill in various types of motor responses. For this reason such studies as are reported in this volume are helpful and perform a distinct service for the student of the learning processes.

Some of the general conclusions resulting from the study follow:

1. Plateaus in the learning curves are not a necessary part of the curves. It is true that they are found in most curves but the evidence tend to show that with proper guidance of the learner they may be avoided. They appear when unfavorable conditions of learning develop.

2. The artist applies himself with great diligence to his task while in a favorable mood. He then relaxes and lounges until seized by another impulse. Certain evidence gathered from the data supplied by the study

tend to support the validity of the *artist's method* of work. There is a suggestion here that the most economical use of time demands that the learner should apply himself to the task only when he can enjoy it. There is the further suggestion that only *vigorous* application is economic.

3. The order in which the different *units* of material were mastered constitutes an important observation. The lower or smaller units were not made perfect before larger units of habits were attempted. The two orders of habits were developed and perfected more or less simultaneously. Here is the author's general summary of this point. "*The lower order habits were perfected in and through the formation of the higher, as a further development of the higher was dependent upon the final perfection of the lower.*"

4. Another important factor in learning refers to the amount and character of the work done. This varied from day to day and was found to be closely connected with the degree of attention given to the task in hand. The degree of attention in turn depended very directly on the physical and emotional state of the learner.

WILLIS L. GARD.
Ohio University.

DAVID R. CRAIG AND W. W. CHARTERS. *Personal Leadership in Industry.* McGraw-Hill Book Company, Inc., New York, 1925. 245 pp.

In a note preceding the first chapter the authors say, "This book is a working plan, leading up to the final chapter on self-training. It should be read as a definition of qualities and character traits involved in effective personal leadership in industry. The last chapter contains a statement of the procedure which can be used in developing these abilities and traits. The reader who is already aware of the nature of his own shortcomings might do well to start with the last chapter, and take his cue from the suggestions contained in it."

If you read the last chapter first, and are concerned with developing greater executive ability as that relates to personal relations, the reviewer suggests that you read the summaries at the close of chapters next and, finally, read the text. This is precisely the reverse order to the way the book was made. It is, however, the way one usually discovers his faults or weaknesses. Also, if you read straight through, you will be too much interested in the illustrations to grasp fully the purpose as above described. In the final chapter, the authors say, "Thus this book was not written for purposes of idle entertainment, nor do its sponsors wish it merely to be read and laid aside." These are important warnings. The form of the book tends to conceal the serious purpose of its authors. It seems popular, and herein lies its danger. A single reading results in a feeling of over simplification.

The theory of the book is set forth in the preface. The authors believe that beside "labor problems" and "personnel administration," there exists a further problem, the relation of the executive to the individual worker. The book is not concerned with relations between individuals of equal rank or authority. With this viewpoint, the authors have concentrated on methods. The illustrative material is drawn from the personal experiences of successful executives. Quotations are frequently used. Without the first and final chapters the frequency of "don'ts" and do's" might well become confusing to any one seeking a unitary view of the purpose of the authors. Perhaps we are dealing here with a relationship which differs materially from the conventional and intimate relations of society. If so, those principles need not apply. Nevertheless, we shall need other books to demonstrate the differences. The niceties of the relations of the young, ambitious executive to his superiors are not touched upon in the volume.

Commendation is due the authors for a very readable book. The purpose of the presentation naturally prevents smoothness of style. The chapter on training where the attitude of the subordinate is used to carry the story seems more appealing to the reviewer. Unfortunately that method does not lend itself to proper self-analysis, which is the main objective. It should prove very useful as a distinct advance over the efforts of popular magazines to show us the successful executive at work with his subordinates.

C. S. YOAKUM,
University of Michigan.

WILLIAM F. BOOK. *Learning to Typewrite with a Discussion of the Psychology of Skill.* The Gregg Publishing Company, New York, 1925. Pp. xvii and 463.

This volume is addressed to teachers of typewriting and to those preparing to teach the subject. The material for the study represents the fruit of several years of investigation and conferences with experts in this skill. The three parts of the discussion supplies the reader with a comprehensive statement of the analysis of the practical and theoretical problems involved in teaching typewriting as well as the general laws of learning any skill.

Part I presents the psychology of skill including the laws which govern the acquisition of skill in general. In the one hundred fifty pages allotted to this discussion the author condenses the results of the many studies relating to the topic. The findings of the various studies are carefully organized and presented in a form which makes them easily accessible to the general student.

The reader may not care to accept the author's explanation of this type of learning in all instances. As one proceeds from page to page the

feeling grows that such learning is nothing more than an organic or a physiological process operating exclusively through the effect of external and material stimuli. In this event learning becomes a physiological process and ceases to be a psychological product. However, on page 55, the author states his psychological position in the following quotation: "Intelligence has been generally defined as successful behavior, or ability to make a *successful* response to new situations or problems where such an adaptation is necessary or desirable. Many attempts have been made to determine the psychological factors or principles which control such successful behavior. One thing is clear; namely, that all the factors which condition this type of behavior are complex and still very much obscured. As a matter of fact, little is known about the *organic changes* which take place in the learner under such conditions, or about the psychological factors which favor or retard a learner's progress in *originating* new and successful responses in learning." It would thus appear that the author finds need for something more than purely organic or physiological processes to explain the acquisition of skill.

Part II presents a scientific analysis of the problems involved in learning to typewrite. In the 175 pages of the book devoted to this task, the author considers the following questions: The four problems confronting every learner of typewriting; the kind of habits that must be acquired; the order in which the habits should be acquired; how habits in typewriting originate and are fixed; the true basis for effective speed; the typical errors that appear during the learning period; some factors that modify the rate of progress and the limits of improvement. This phase of the discussion closes with the consideration of some means of measuring the progress made by the pupil. This list of topics is sufficiently comprehensive to give the reader a knowledge of the essential factors involved in acquisition of this special skill and to form the basis for an intelligent and economic procedure in teaching typewriting. When these laws and principles here presented become operative in the acts of those who direct the learning of pupils to typewrite, we shall then have gone far toward placing the acquisition of this special skill on a scientific basis.

Part III explains the rôle of the teacher in selecting and directing learners of typewriting. About 125 pages of the book are allotted this topic. Something of the special service rendered by the teacher in this connection may be gathered from the following list: the need, basis, and kind of direction supplied by the teacher; the guiding of the student in following the laws of habit formation; the developing and maintaining of the proper attitude of the learner toward the task; the evaluating of the progress made by the student; and the aiding of pupils to select

the subject with proper insight into its possibilities. This section closes with an account of the special abilities of the world's champion typists.

While the book is not a study of the methods of teaching typewriting, it supplies an excellent basis for such a course. Here are found the results of many investigations presented in a usable form. The topics discussed are carefully analyzed and set forth in the table of contents. This is an excellent feature of the book. Besides we have a well selected list of questions and exercises at the close of each chapter. To some the book may appear to be tedious owing to the detailed and often repetitive character of some of the discussions. This is recognized by the author. It should however be remembered that the author here is engaged in a new undertaking and of necessity detailed explanations must be indulged in.

On the whole the book serves a special function in our educational literature and deserves to be imitated in other fields where the acquisition of skill is the major consideration.

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NEW BOOKS AND PAMPHLETS RECEIVED*

Books and pamphlets for review should be sent to James P. Porter, Department of Psychology, Ohio University, Athens, Ohio.

American Association for the Study of the Feeble Minded. The Journal of Psycho-Asthenics, Vo. XXX, June, 1924, to June, 1925. Edited by Howard W. Potter, M.D., Thiells, N. Y. 360 pp.

Attention-Value of Newspaper Advertisements. RICHARD B. FRANKEN. Association of National Advertisers, New York, 1925. 55 pp.

Children's Drawings. STELLA AGNES MCCARTY. The Williams & Wilkins Company, Baltimore, Md. 164 pp. $3.00.

Employer-Employe Relations in Hotels. W. I. HAMILTON. The Williams & Wilkins Co., Baltimore, Md. 158 pp. $3.00.

Experience and Nature. JOHN DEWEY. Open Court Publishing Co., Chicago. 443 pp.

Genetic Psychology Monographs. Carl Murchison, Editor. Vol. 1, No. 1, January, 1926. Clark University, Worcester, Mass. $7.00 per annum.

Health Maintenance in Industry. J. D. HACKETT. A. W. Shaw Company, New York. 488 pp. $5.00.

How to Make a Course of Study in Arithmetic. M. E. HERRIOTT. University of Illinois Bulletin, Vol. 23, No. 6. Urbana, Ill. 49 pp.

Improvement of the Written Examination. G. M. RUCH. Scott, Foresman & Company, New York. 193 pp.

Intelligence and Immigration. CLIFFORD KIRKPATRICK. Mental Measurement Monographs. Serial No. 2, January, 1926. The Williams & Wilkins Company, Baltimore, Md. 127 pp.

La Prophylaxie Mentale. Edited by Le Mouvement Sanitaire. 4 Rue de Sevres, Paris. 48 pp.

Memorias del Instituto de Reeducacion Profesional de Invalidos del Trabajo. No. 2. Madrid. 131 pp.

Mental Capacity of American-born Japanese Children. MARVIN L. DARSIE. Comparative Psychology Monographs, Vol. III, No. 15. The Williams & Wilkins Company, Baltimore. 89 pp.

Objective Psychopathology. G. V. HAMILTON. C. V. Mosby Company, St. Louis, Mo. 354 pp.

* Mention here does not preclude further comment.

Outline of General Psychology. ROBERT H. GAULT AND DELTON T. HOWARD. Longmans, Green & Co., New York. 474 pp.

Personal Leadership in Industry. DAVID R. CRAIG AND W. W. CHARTERS. McGraw-Hill Book Company, New York. $2.50. 245 pp.

Political Action. SEBA ELDRIDGE. J. B. Lippincott Company, Philadelphia. 382 pp. $2.00.

Preparation and Use of New-Type Examinations. DONALD G. PATERSON. World Book Company, Chicago. 87 pp.

Psychological Healing. PIERRE JANET. Volumes I and II. The Macmillan Company, New York. Vol. I, 698 pp. Vol. II, 1265 pp.

Psychology of Skill. W. F. BOOK. Gregg Publishing Company, New York. 257 pp.

Psychology of Selecting Men. DONALD A. LAIRD. McGraw-Hill Book Company, New York. 274 pp. $3.00.

Psychology of Misconduct, Vice and Crime. BERNARD HOLLANDER. Macmillan Company, New York. 220 pp.

Psychologie und Medizin. DR. R. W. SCHULTE. Vol. 1, No. 1, October, 1925. Stuttgart. 112 pp.

Psychology of Selling and Advertising. EDWARD K. STRONG. McGraw-Hill Company, New York. 467 pp.

Source Studies in American Colonial Education. The Private School. ROBERT FRANCIS SEYBOLT. University of Illinois Bulletin, Vol. 23, No. 4. Price 50 cents. University of Illinois, Urbana, Ill. 109 pp.

Statistical Tables for Students in Education and Psychology. KARL J. HOLZINGER. University of Chicago Press, Chicago, Ill. 74 pp.

A Technique for the Experimental Investigation of Associative Interference in Artificial Linguistic Material. ERWIN ALLEN ESPER. Language Monographs, No. 1, November, 1925. Linguistic Society of America, 204 St. Mark's Square, Philadelphia. 45 pp.

Understanding Our Children. FREDERICK PIERCE. E. P. Dutton & Company, New York. 198 pp. $2.00.

Union List of Foreign Serials cited in Psychological Index, 1922. Research Information Service, National Research Council, Washington, D. C. 21 pp.

Why Children Succeed. S. A. COURTIS. Friesema Bros. Printing Company, Detroit. 271 pp. $1.50.